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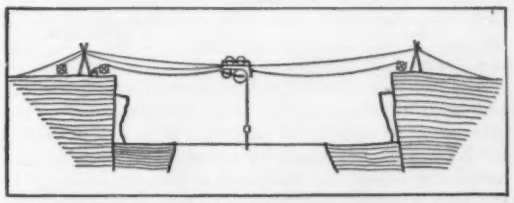
Collecting gases in the active lava pit of Kilauea

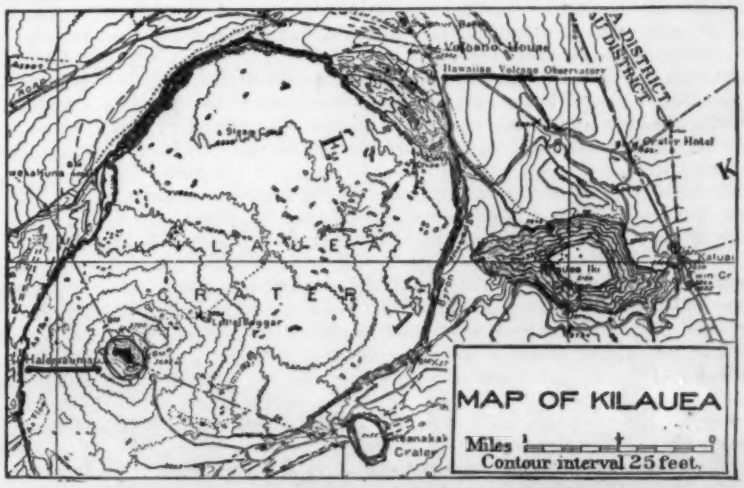
Exploring Live Volcanoes

THE study of volcanoes was entering a stage of unprecedented activity when the political eruption in Europe came to divert the thoughts of mankind from the less disastrous outbreaks of Nature. Volcanology was beginning to be recognized as an independent branch of science, and not merely a bypath of geology. One token of its new status was the establishment, in 1914, of an international journal devoted exclusively to volcanology, under the editorship of Immanuel Friedländer, of Naples. The investigation of the Hawaiian volcanoes, probably the most hopeful of all enterprises designed to throw light upon the more abstruse problems of volcanism, was begun in a thorough and scientific way by Perret and Shepherd in 1911, and in the following year the Hawaiian Volcano Observatory began its remarkable career under the direction of Professor Jaggar.

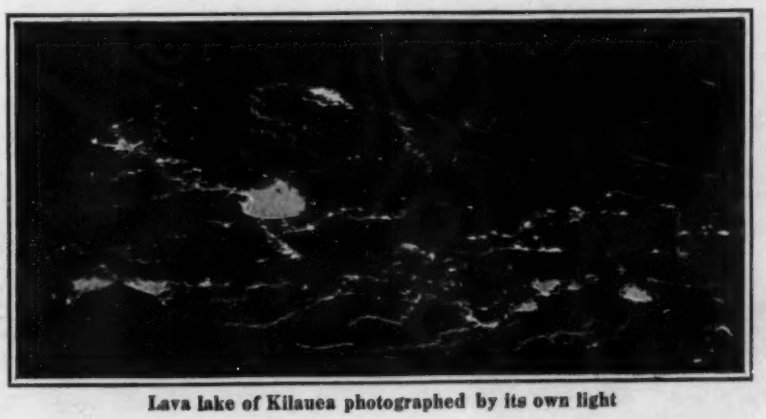
Plans were on foot just before the war began to found a volcanic observatory and laboratory in the island of St. Vincent, West Indies, as a memorial to the English student of the Antillean volcanoes, Dr. Tempest Anderson. The gigantic eruption of Katmai, in Alaska, in June, 1912, afforded American volcanologists a fruitful field for investigations which, at this writing, are still in progress under the leadership of Professor Griggs. At Vesuvius Malladra had made his sensational descents into the crater. The disastrous eruption of Taal, in the Philippines, had been thoroughly studied by the staff of the Philippine Weather Bureau. In January, 1914, occurred the eruption of Sakurajima, the greatest outbreak that Japan has experienced in recent times. This eruption has been the theme of voluminous and beautifully illustrated reports by Japanese authorities, especially Omori and Koto. Few eruptions have been more thoroughly studied. In May, 1914, began the series of outbreaks on the part of our solitary domestic active volcano, Lassen Peak, and this has formed the subject of painstaking investigations on the part of Diller and others. Lastly, the Geophysical Laboratory of the Carnegie Institution, in Washington, under Dr. A. L. Day, was fully embarked upon brilliant researches in petrology which are essential to the solution of the problems of volcanism.



How the temperature of the lava was measured



Location of the observatory and of the lava pit of Halemaumau



Lava lake of Kilauea photographed by its own light

This catalog of volcanological activities is not complete, but it will suffice to show how serious and many-sided a campaign was in progress up to the outbreak of the European war. Of subsequent investigations those now carried on in Hawaii are easily the most notable. The Hawaiian Volcano Observatory, located on the edge of Kilauea crater, is maintained by an association of about 150 public-spirited individuals and firms, in Hawaii and elsewhere, and its scientific work is under the oversight of the Massachusetts Institute of Technology. The investigations in this huge crater are concentrated especially at the pit of Halemaumau, about 2,000 feet in diameter, which contains a more or less permanent lake of lava. The lava is continually changing in condition and level. Sometimes it drains away entirely through subterranean vents, and the whole pit, 1,000 feet in depth, is empty. At other times the lava rises to the top of the pit and overflows into the main crater of Kilauea. As a rule the surface of the lava is partly solidified; the central portion is liquid, and interspersed with spouting fountains, while a thin solid crust around the edge constitutes a temporary "shore."

The most daring exploits of Prof. Jaggar and his associates consist of descents down the nearly perpendicular walls of the pit, scores or hundreds of feet in height, to the hot crust of the lava, subject at any moment to be overflowed or to crumble into the central lake. Having gained this precarious footing, equipped with gas-masks to protect them from the poisonous vapors, the investigators measure the temperature of the liquid lava by lowering into it a series of cones of different known fusibilities. Other remarkable achievements include collecting specimens of gases by means of pipes led into the dome-like enclosures which sometimes form over fountains of lava spouting through the floor. The samples thus taken before the gases have been exposed to the air, are pumped into glass collecting tubes and brought away to be analyzed at leisure in the

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The object of this journal is to record accurately and lucidly the latest scientific, mechanical and industrial news of the day. As a weekly journal, it is in a position to announce interesting developments before they are published elsewhere.

The Editor is glad to have submitted to him timely articles suitable for these columns, especially when such articles are accompanied by photographs.

Find the Leak

IN spite of the fact that the official account of the attack on our transports is now believed to have been rather highly colored, it is evident that the Secretary of the Navy believes that, whether the enemy appeared in force or not, his meeting with the fleet was not accidental but was due to exact information as to the speed and course of our transport fleet—information which must have been sent to him from this side of the Atlantic.

If this be so, how did the German Admiralty become possessed of so much detailed information? Certainly not from German sympathizers who saw the accumulation of men and material at the ports of departure; for although these people knew that many ships had sailed they had absolutely no means of knowing what course the fleet would follow, or its sailing speed.

In a great naval movement of this kind, in which secrecy, particularly with regard to the route and speed, is of the first importance, the plans are drawn up by, and are known only to, a group of high ranking officers who control all the operations of the fleet. It has been the custom from time immemorial, and we presume it is the custom today, to send an expedition of this kind to sea under sealed orders, which are opened by the Commander-in-Chief only when the fleet is well at sea. It is certain that no leak occurred from the fleet itself. Therefore, this priceless information must have been gained by the enemy, either in Washington, or by interception of the cable messages instructing our destroyer flotilla where and when to meet the transports; or by some crafty work upon the part of German sympathizers or spies on the other side of the water.

So far as Washington is concerned, despatches from that city announce that the Department of Justice is making a searching investigation to determine whether the plans of the Department were obtained within the Navy Department itself. It is of course, absolutely unthinkable that any Naval officer, especially the high-ranking officers who alone would be familiar with the facts, has been guilty of indiscretion. If ever in the history of our Navy there was a call for profound silence, it was here in connection with the sending of our forces across the Western ocean; and we may rest assured that so far as our Naval officers are concerned the secret was well kept.

If there was any leak from the State, War and Navy Building, it must have come either through some civilian employee, or through the diabolically clever work of German sympathizers, or of some professional member of the German Secret Service. If the Department of Justice believes that the treachery occurred at headquarters, no doubt they will go through the matter with a fine-toothed comb. In their search, moreover, they will bear in mind the now well-established fact, that the German Secret Service has been in the habit of laying its plans for such an emergency as the present war, long before the event. If the German Secret Service has succeeded in placing one or more agents in our government departments in Washington, we may be sure that the thing was done many years before the present war; and we may rest assured also that these German agents were possessed of special qualifications. It would be laid down as a *sine qua non* of successful operation that the agent should not bear a German name; that he should be inconspicuous, unassuming, obliging and never inquisitive; and that he should in every way so comport himself as to inspire the fullest measure of confidence.

Before a great many months have passed we shall be sending half a million of the flower of young manhood across the ocean. Already, according to the Secretary of the Navy, there has been strong presumptive evidence on two separate occasions that advance information of the movements of our Naval ships across the Atlantic has been obtained by the enemy. They knew when our destroyer flotilla would arrive; they knew at what harbor it would enter; and, at the opportune time, they strewed mines in its way. And now, in the case of the recent attack, Secretary Daniels is evidently of the opinion that they knew where on the broad Atlantic and on what night they could waylay our transports.

If we are going to put our armies across the Atlantic with any sense of security, this leak has to be found and stopped for all time; and it is the patriotic duty of every citizen, inside of the Navy or out, who can throw the least light upon this most serious matter to put himself or herself in immediate touch with the Department of Justice.

Points on the Torpedo

IN spite of the exhaustive article on the torpedo which appeared in our issue of June 2d, we are continually receiving numbers of queries as to the speed, range, weight of explosive, depth of submersion, etc., of the torpedo, and we take this opportunity of summarizing the answers.

The speed of a torpedo will vary according to the conditions. The largest, such as the Bliss-Leavitt torpedo, has a range of 10,000 yards with a speed of nearly 40 knots. To secure this result means great size and weight. The warhead of this torpedo contains over 300 pounds of high explosive, and the weight of the air in the air flask (used for driving the engine) will be over 200 pounds. The diameter is 21 inches and the length about 20 feet.

The Germans are using a torpedo of about the same size and presumably of about the same range and speed for their warships; but in designing a torpedo for their submarine work they realized that a range of 10,000 yards at 40 knots was unnecessary, for the reason that the submarine can draw up quite close to its target before letting fly. Hence they reduced the power of the engine and the size of the air flask, and increased the warhead charge to 425 pounds. These torpedoes have a range of probably not over 2,000 or 3,000 yards, with a probable speed of about 30 knots. This is the type of torpedo that was used in the early days of the submarine piracy against merchant ships. But when the ships began to arm themselves and the submarine could no longer sink them by gunfire, it became necessary to increase the number of torpedoes carried. This we have learned on good authority is being accomplished by making use of an early type of the 14-inch Schwartzkopf, and sacrificing speed and range by doubling the warhead charge. These torpedoes will probably have a range of not over 1,500 to 2,000 yards.

The distance of a submarine from a vessel when it fires its torpedo depends upon the conditions during the attack. It is difficult to make the correct calculations for hitting a ship many thousand yards distant, and hence the submarine commander tries to edge up to within 1,000 yards—preferably to between 500 and 600 yards before firing. It is doubtful if he would think it worth while to risk a torpedo at over 1,500 to 1,800 yards. unless, indeed, the ship attacked was steaming at unusually slow speed.

The depth below the water at which the torpedo travels is determined by the torpedo officer on the submarine. This depth is controlled by a diving rudder at the tail, which is operated by the movements of a diaphragm which is subject to water pressure—the deeper the torpedo goes the greater is this pressure and thus the greater the movement of the diaphragm. The diaphragm is regulated by a spring, the tension of which is set to correspond with the depth at which the torpedo is to run. So well does this depth-control function, that after the torpedo has been fired it seeks, at once, the predetermined level, and continues to run on that level, which is usually somewhere between 8 and 15 feet, until it strikes the ship. In case the attack is on a vessel of shallow draft, such as a destroyer, the depth mechanism is set so as to cause the torpedo to run only a few feet below the surface.

It should be understood that it is not necessary for the submarine to be at the depth at which the torpedo is to travel; for whether the torpedo is fired when the submarine is traveling at the surface or 20 to 30 feet below the surface, makes no difference to the torpedo, which under the guidance of its diving rudder will descend or rise as the case may be, until it reaches the depth of 12 or 15 feet at which it is set to run. If the torpedo is fired when the top of the periscope is above the surface for observation, the torpedo tubes will be from 20 to 25 feet below the surface of the water, the depth, of course, varying according to the size of the submarine.

It might be mentioned here that the course of the torpedo follows a slightly wavy line, the action of the hydrostatic valve and the diving rudders causing the torpedo to run slightly above and then slightly below its mean line of flight. The amplitude of this curved line is greatest at the start of the flight, and diminishes to practically nothing as the torpedo gets well under way.

The detonation of the high explosive is caused by a percussion fuse, the striker of which is a small metal rod projecting through the nose, which when contact is made with the ship is driven in, firing the charge.

Lastly, we draw attention to the fact that all of the protective devices designed to stop the torpedo have to contend against very high dynamic forces, for the largest torpedoes, such as the 21-inch Bliss and the 22-inch German torpedoes weigh about 2,500 pounds and travel at a speed of 40 knots. Hence, it is evident that any netting or steel plates that seek suddenly to arrest this onrushing mass must be of very considerable strength.

Small Water Powers

OUR large water power possibilities are being developed perhaps as rapidly as is justifiable, all things considered. The small powers, where the rights involved all lie within the title of one or two property holders, are free from the legal troubles which so often hamper the larger projects; but their development seems almost prohibited by the necessarily high cost of determining all the engineering values involved.

Nevertheless, with the rapid development of uses for the small motor in driving almost every contrivance about the farm, and the increasing production of labor-saving contrivances to be driven, a source of small power for isolated places is becoming daily more imperative. There are, of course, small engines that are partly filling this growing demand, but where water power is available it has obvious advantages. But how to apply it effectively is a matter involving so many questions which, while engineering commonplaces, are as Greek to the farmer and rural resident, that the small water power lags far behind its bigger brother in making itself useful.

The solution of the problem would seem to be along the line of standardization. Of course, from the point of view of the big engineer accustomed to careful working out of each detail so as to utilize every last pound of water and every last inch of drop in some titanic fall, standardization of millponds and spillways is an impossibility. But let us go at the problem from the other end. From the point of view of one who is familiar with the incredible cost reductions effected by standardization in construction, the stream must be adapted to a standard dam, even if the dam chosen be half or twice as large as good engineering would demand.

Why should not our smaller streams be systematically surveyed and classified with respect to their power possibilities? Why should we not have half a dozen or a dozen standard turbines, both vertical and horizontal, of various horse-power from perhaps two or three to say ten or twelve, with standard gear change apparatus and other standard accessories, perhaps even with standard dams and spillways? Each customer could select the smallest set that would do the work he had in mind, or the largest set that his stream would support. To be sure, in the one case he might use but a fraction of the power his stream is capable of developing, while in the other he might be developing several times as much power as he could use. But what if the thing were crude in an engineering sense? What if the installation is only 50 per cent efficient, if it does all the user requires of it?

With such standardization seriously put before the owners of our little water powers, surely it would not be long before these would become in truth our great water powers, dwarfing in the extent and value of their application the combined forces of a dozen Niagaras.

Are We to Have a Scientific Moratorium?

FROM time to time we learn that one or another of our scientific societies has deemed it advisable, on account of the war, either to cancel or to postpone meetings and conventions. This action, we believe, is altogether hasty. In order to expedite the solution of many of the new problems that have arisen as a direct consequence of our martial state, unrestricted discussion at scientific meetings is bound, in all but a very few cases, to give all of us a clearer understanding of the real points at issue and the needs of the country.

Meetings of scientific and technical societies have from time out of mind served as a great stimulus to the members, and have been a sort of clearing house for many of the best thoughts and ideas of our professional men. We should, accordingly, encourage rather than discourage the holding of such meetings throughout the period of the war. We should follow the example of England on this point. Finding that the country was face to face with a serious shortage of sulfuric acid, glass, dyes, electrodes, and many other essentials of industry, the British scientific societies arranged symposiums on these topics and not only urged all members to attend, but invited factory men to come and give their views and experiences, in exchange for those of the theorists. Much of value was accomplished in this manner.

Just as the great business concerns depend upon the organized efforts and efficiency of the several departments, so the government, in time of war far more even than normally, looks to the concerted action of its technical bodies for quick and efficient results. Let us continue to hold our meetings, more frequently even than before. We cannot afford a scientific moratorium.

Naval and Military

Wooden versus Steel Boats.—The controversy as to whether wooden or steel boats should be built seems to us to be rather wide of the mark. We need both and both can be built without serious inconvenience. The class of skilled labor required for wooden shipbuilding is entirely different from that needed for the construction of steel ships, especially as regards the hulls. The first call on labor, of course, should go to steel ships, but when that demand has been satisfied, we should bend our efforts to put every wooden ship afloat that can be built.

Report on the "Mongolia" Accident.—Apropos to our editorial statement on the "Mongolia" gun accident, we quote the following from a report of Admiral Ralph Earle, Chief of the Bureau of Ordnance: "When the gun is fired, the shell, followed by the brass cup, is expelled from the muzzle. The brass cup sometimes remains whole and sometimes does not; but it, or its pieces, are always expelled some distance from the muzzle of the gun. The fact that these pieces, or the cup itself, might return on board has not been seriously considered, because this type of ammunition has been fired constantly in the naval service for at least 20 years, without such an occurrence in this or other navies so far as known."

A Most Commendable Enterprise.—We have before us the second issue of the *Reservist*, which is published weekly by members of the Newport Section of the United States Naval Reserve Force, Second Naval District. If this number is a fair sample of what the publishers are going to put into the hands of the Reservist week by week, the Newport Section is to be congratulated. The paper is excellently edited, is thoroughly readable, and gives exactly the kind of information which the Reservist will be looking for. A notable article in this issue (the first of a series that will run in the *Reservist*) comes from the pen of Commander C. D. Stearns, U. S. N., Commander of the Second District Force, the subject of which is "The Relation of a True Policy to War." Here is an excellent venture which we commend to the consideration of all the voluntary naval and military organizations which are identified with the present war.

New Naval Base on the Chesapeake.—The President has taken over the Jamestown Exposition and Piney Branch grounds on Hampton Roads for the development of a great naval base on the Chesapeake. For the purchase $1,200,000 was provided and $1,600,000 for improving and equipping the base. The more permanent buildings of the Jamestown Exposition will be overhauled and prepared for occupancy. Barracks, hospital, pavilion, etc., will be erected for the accommodation of 10,000 naval recruits. In addition to being a training station for 10,000 men, the base will also include a submarine base, an aviation operating base, oil and fuel storage for the fleet, storehouses for all fleet stores held ready for delivery, torpedo storehouses for reserve torpedoes; and a medical storehouse. There will be a boat basin for training and aviation launching slips. Ultimately, by dredging and filling in, the area will cover about 1,200 acres with a frontage of a mile on the deep-water channel leading to Norfolk.

Doubling the Shipbuilding Program.—The United States Shipbuilding Board is seeking to have the appropriation for new merchant shipping increased by the appropriation of an additional $500,000,000. If Congress should agree to this, the Board believes that between 5,000,000 and 6,000,000 tons will be built during the next eighteen months. Chairman Denman states that the present appropriation of $500,000,000 will not replace in eighteen months more than four-fifths of the ships destroyed by U-boats since February 1st. The first half-billion dollars will only about cover the contracts let, or shortly to be let, for steel vessels and a few wooden vessels. The larger part of the additional half-billion would go for wooden ships, and the smaller of these could take care of our coastwise traffic releasing the larger coastwise ships for trans-Atlantic service. Mr. Denman believes that many serviceable wooden vessels can be built which would be faster than the majority of vessels which are now crossing the war zone.

Shipbuilding Capacity of Our Navy Yard.—Secretary Daniels has announced that with the shipways now being built or projected, the United States Navy Yards will have a construction capacity at one time of sixteen war vessels on the ways in addition to submarines and submarine chasers. This would include seven battleships, two auxiliaries (such as transports, fuel ships, etc.), and seven destroyers. Since much of the work is done on vessels before the keels are laid and after their launching, there could be under construction in the yards at one time at least double the number of ships as given above for which building ways are available. This construction work is in addition to the repair work and rebuilding of the fleet which goes on continually. Thanks to the dry docks now under construction, the Navy will be able to dock the biggest ships such as the "Mauretania", "Vaterland" and "Olympia"; for there are three naval docks now building which will be of sufficient size to take these ships.

Science

Dr. G. Müller has been appointed director of the atrophysical observatory at Potsdam, Germany, in succession to the late Professor Karl Schwarzschild.

The Keeping of Vaccine Virus.—The U. S. Public Health Service calls attention to the fact that vaccine virus rapidly loses its potency unless kept cool. Anybody who buys vaccine virus should make sure that it has been kept in an ice-box, and not, as is the custom in some drugstores, in a drawer back of the counter. Properly it should be kept not only in an ice-box, but in a metal container in actual contact with the ice itself. It cannot be kept too cold.

Time Signals by Electric Lights.—A new kind of time signal has recently been installed at the Hector Observatory, Wellington, New Zealand. Three electric lamps are mounted in a vertical row on the observatory flagstaff, 6 feet apart; the lowest green, the middle red, and the highest white. The lights are switched on 50 minutes, 10 minutes and 5 minutes, respectively, before the hour of the signal, at which hour they are all extinguished simultaneously. The signals are given at 20 hours, 21 hours and 22 hours, Greenwich mean time.

"Health Insurance."—Is this term a misnomer, and should it be replaced by "illness insurance"? The recent fifteenth annual conference of state and territorial health authorities with the U. S. Public Health Service adopted a resolution to the effect that, in the opinion of the conference, the use of the phrase "health insurance" to describe a system of sickness relief that makes no specific, positive and definite provision for the conservation of health, is liable to endanger the efficiency of existing health agencies and retard their further development.

Light Curves of Variable Stars.—At the spring meeting of the American Association of Variable Star Observers, as reported in *Popular Astronomy*, several charts of unusual interest were exhibited. One of these showed the history for 20 years of continual observation of the variable star 213843 SS Cygni, the best observed star of those of irregular type. Not one maximum has been missed since the association was formed. Another exhibit was the plotted curve of the variable 154428 R Coronæ Borealis, presenting a careful 15 years' record of its remarkable variations, and showing in a striking manner its present rapid decline of six magnitudes.

The Origin of the Southern Constellations.—The origin of the constellations, unknown to the ancients, in the region surrounding the south pole, has been attributed to various early Dutch, Spanish, Portuguese and Italian navigators, but the history of this subject is involved in obscurity. The question has recently been taken up by Mr. E. B. Knobel, who presents the results of some painstaking investigations in the *Monthly Notices*. In 1603 Frederick de Houtman published at Amsterdam a Malay and Madagascan vocabulary, at the end of which he gives a catalogue of southern stars, which he claims to have observed in Sumatra. A copy of this rare work is in the Bodleian Library, where Prof. Turner has had it photographed. It gives right ascensions, declinations and magnitudes of 303 stars, of which only 107 were known to Ptolemy. Mr. Knobel adduces, however, a large amount of evidence to show that the formation of this catalogue, and of the twelve new constellations which it contains, was really the work of Pieter Dirckszs Keyzer, an officer of the ship on which de Houtman made his first voyage to the East Indies. Apparently the latter obtained a copy of it and published it after the death of Dirckszs as his own work. This view has also the support of Dutch scholars, and the Linschoten Society contemplates publishing a full account of Pieter Dirckszs Keyzer.

Cicadas and Soil Composition.—Is the distribution of the periodical cicada, or "seventeen-year locust," influenced by the character of the soil? This question is raised by Mr. H. A. Gossard, of the Ohio Agricultural Experiment Station. As early as 1914 Dr. G. N. Coffey, who was making a survey of Ohio soils, recognized that the brood maps of the periodical cicada in Ohio coincided in a striking way with the soil maps established by his survey. Mr. Gossard has made further investigations of this subject, and finds strong evidence of a relationship between the distribution of the insect and the types of soil in the case of most of the recorded broods, though not all. Probably the relationship is obscured in some cases by the operation of other factors. An alternative, but improbable conclusion is that the causes which fixed the soil areas at the same time directly operated to determine the cleavage lines between the broods. Whether, says Mr. Gossard, the presence of lime in the soil on one side of the boundary line of a brood and its relative absence on the other can stimulate or retard development in some direct way—such as by acting on chitin formation—or indirectly through chemical constituents of the food, or whether some drainage factor operating at a critical stage—as at pupation—or a temperature factor must be found to explain the phenomenon, we are not yet in a position to determine.

Industrial Efficiency

Automatic Feeding of Envelopes into a Typewriter.—In the addressing of envelopes on a typewriter a considerable amount of time and labor is expended in feeding the envelopes into the machine. This ordinarily requires three operations: Picking up an envelope from a pile, placing it in the machine, and straightening it. Fitting all machines and sold at a reasonable price, there has of late been introduced a machine which automatically feeds envelopes into a typewriter, one by one, and each in perfect alinement. The machine takes one hundred or more envelopes at a time, and feeds them automatically so that there is always an envelope in position.

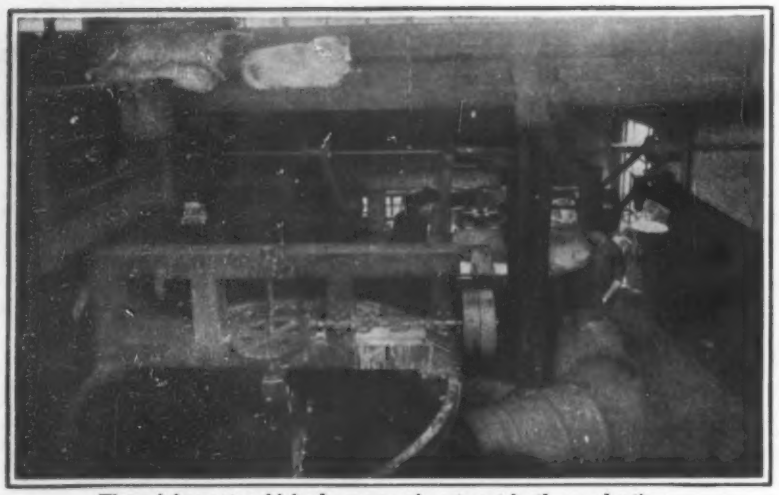
Fuel Wood from the National Forests.—To meet any possible coal shortage in the West next winter, more extensive use of fuel wood from the National forests is urged by the Government's foresters. The supervisors of the 153 National forests will afford all possible facilities to local residents wishing to obtain cord wood, which settlers may obtain free for their home use, and which is sold at low rates to persons cutting and hauling in order to sell to others. During the last fiscal year more than 30,000 permits for the free use of National forest timber, mainly in the form of fuel wood, were taken out by local residents. The amount of timber involved approximated 250,000 cords.

An Automatic Payteller for the Payroll.—A machine that indicates the amount due in every man's pay envelope the instant it is wanted is among the latest office devices. This machine, it is said, gives the products of payrolls and distributes job costs in far less time than the most expert clerk can deduct them by pencil and pad. A twist of the wrist gives the product of the most involved payroll fractions—whatever the rate per hour or the hours worked may be. Perhaps most remarkable of all is the fact that the machine does not compute products; instead, it has 18,340 computed products which cover all conventional payroll figures. The machine occupies little space and is compact and portable.

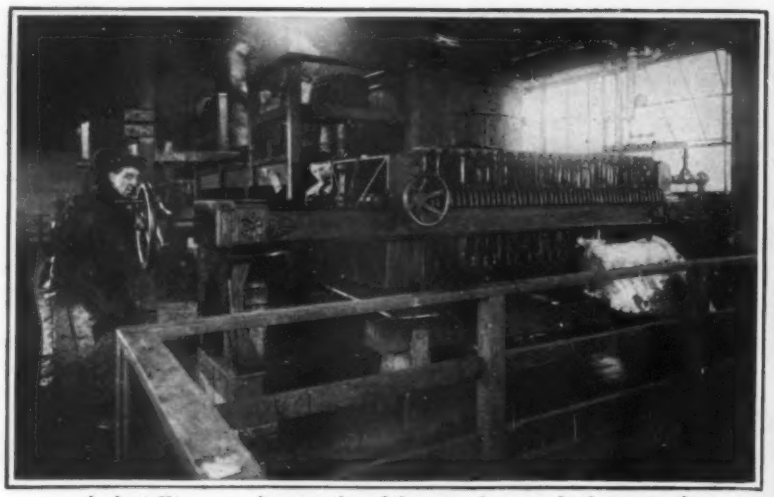
How Germany Employs her Blind.—According to the *Elektrotechnische Zeitschrift*, the authorities in Brandenburg, Germany, have been endeavoring to find occupation for men who have lost their eyesight, and a number are now being employed in the Siemens-Schuckert Works. They are found quite serviceable for such work as gaging small parts, stamping numbers, packing small articles and testing fuse plugs acoustically. A room is given up to their working, and special precautions are taken in the location and fencing of machines and the elimination of sharp projections that might cause injury. The workers are paid a minimum wage of 28 pf. (about 7 cents) per hour, but some earn as much as 55 pf. (about 14 cents). It is stated that they prefer machine work to hand work, the noise of the machine being apparently a useful guide to the progress of each operation.

Choosing Employees by Test.—During recent years much has been heard on the scientific use of human material, including the careful selection of men best suited for various classes of manual labor. Some refinements in methods of selection are described by Mr. W. F. Kemble in a recent issue of *Industrial Management*. An important point is the discrimination between strength and manual dexterity. A number of devices are proposed for testing the latter quality, such as the time to transfer a number of matches from a pan into a series of holes prepared for them. For other classes of work strength of fingers and forearm may be tested with the ergograph, or, again, grip may be tested with a dynanometer. As regards manual dexterity, the shape of the hand and fingers often offers a good guide. It is said that the very finest typists have exceptionally small fingers, and that generally small dimensions tend to quickness and deftness of movement.

A Safety-First Sign with a Constantly-changing Message.—At the reduction plant of a leading copper mining company in Montana there has recently been set up in a conspicuous position a sign of steel and wood construction, 16 feet wide and 11 feet high. The front of the sign is divided up into eight panels, each capable of holding from 30 to 35 six-inch steel enameled letters. These letters are white on a green background, white on green being the entire color scheme of the sign, excepting the copper-colored rim of the clock and the ingot inserted in the dial. The letters are interchangeable. This factor makes the sign flexible to a very great extent, since it permits frequent changes in the reading matter. Some of the wording is changed every day, so that the message is always fresh, interesting and timely. A practice is made to show in the upper two panels the number of accidents that occurred in the plant in the preceding 25 hours and the departments where the accidents took place. The other panels are used for Safety-First slogans or Safety-First rules or other subject matter pertinent to accident prevention work. At night the sign is illuminated by a flood-light projector.



The mixing vats which play a prominent part in the production of most dyes



A giant filter press in operation, doing on a huge scale the work of the funnel and filter-paper

The Evolution of Artificial Dyestuffs

How American Workers are Reducing the Mazes of Coal-Tar Chemistry to Their Lowest Terms

By Prof. Thomas H. Norton, Ph.D., Sc.D.

THE layman who has casually come into contact with synthetic color manufacture concludes instinctively that there must be a great variety of operations involved in an industry that deals with such complex compounds, and yields products whose number runs well into the thousands. The contrary is the case. Elementary materials are few in number, and equally few are the chemical and mechanical operations required to transform them into an almost endless variety of shades and tints.

Five Stages in the Evolution of Colors

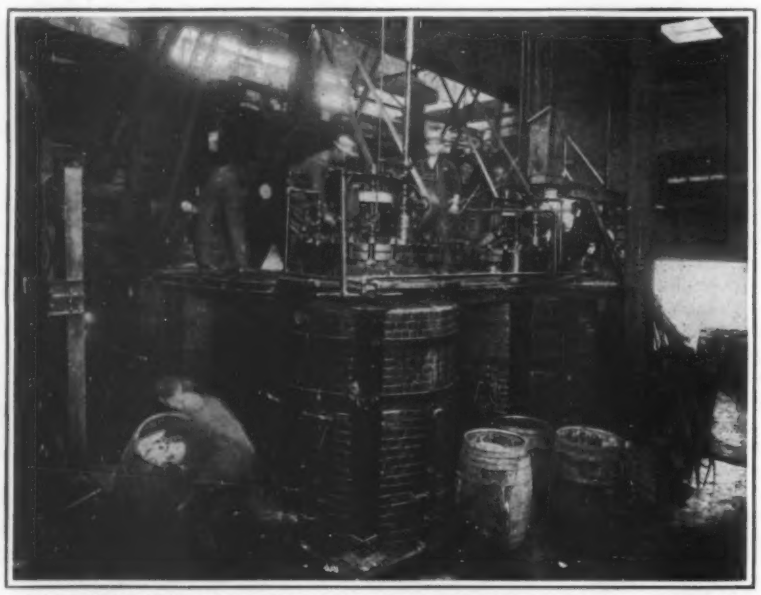
If we analyze the evolution of a synthetic color, the various stages are as follows:

1. Bituminous coal is submitted to destructive distillation.

2. From the volatile products of distillation, coal tar is condensed and separated, and a few volatile hydrocarbons are recovered from the current of gas by passage through so-called benzol scrubbers.

3. The coal tar is submitted to fractional distillation. Among nearly two hundred distinct chemical compounds present in the tar, some eighteen are isolated, possessing more or less value in the synthetic production of colors, medicines, explosives, flavors, perfumes and photographic developers. This total output is augmented by additions from the benzol scrubbers. Of the small group of useful constituents, of chief importance in the color industry are benzene, toluene, naphthalene, anthracene and phenol. The rest, including the three isomeric xylenes, pseudocumene, methyl-anthracene, phenanthrene, and the closely allied carbazole among the hydrocarbons, the three isomeric cresols, and the bases acridine, pyridine and quinoline, play minor although useful rôles.

4. The various coal-tar crudes, as these eighteen substances are termed technically, after being carefully purified, undergo complete transformation by treatment with a few chemicals. Through successive operations the chemist produces from them about three hundred so-called intermediates. These, with a few exceptions, are not susceptible of direct use in the arts. They serve simply as stepping stones.



Making "H-acid," an essential constituent of many important colors. "H-acid" is just a pet name, its full title being too long for technical use

5. One or more intermediates are submitted to a chemical reaction, bringing about combination or material alteration in molecular structure. The resultant product undergoes the necessary mechanical treatment—filtering, drying, etc.—and constitutes then a commercial ware.

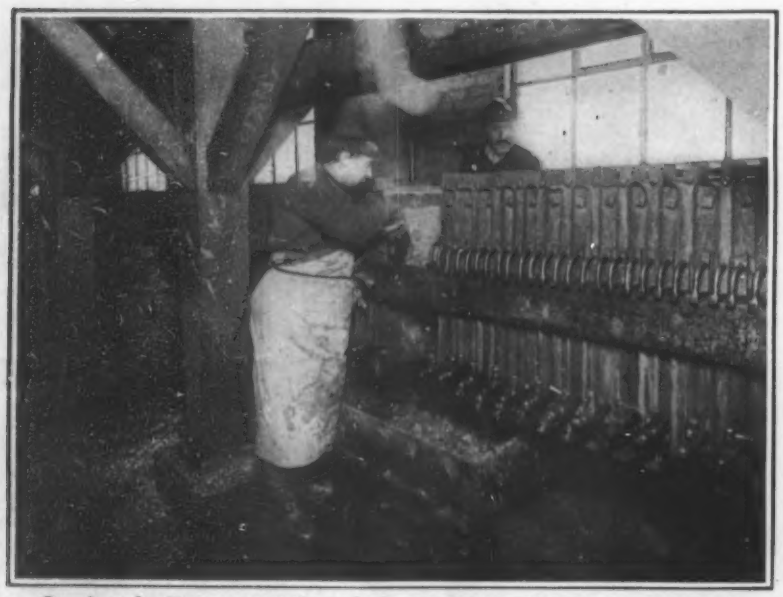
We know but little of the exact combined forms in which carbon, hydrogen, oxygen and nitrogen are present in bituminous coal. Limited, also, is our knowledge of what takes place in a coke oven, as, under the influence of a high temperature, scores of different chemical individuals spring into existence. The initial stage is, therefore, one largely if not wholly of a mechanical nature. The same may be said of the second and third stages connected with the collection, separation and purification of the coal-tar crudes. It is in the fourth and fifth stages that the chemist dominates, and mechanical features assume a purely subordinate position.

In the fourth stage, the manufacture of intermediates, we encounter the great mass of perplexing difficulties. The German and Swiss companies engaged in this branch have mastered these difficulties, have coördinated all the multitude of accessory factors, scientific, technical and commercial. Herein lay the secret of their ability so largely to dominate the world's trade in artificial dyes. Through the thorny mazes of this chemical jungle are struggling, at this moment, hundreds of American coal-tar chemists, determined to achieve as complete a grasp of the complicated industry as their professional rivals on the banks of the Rhine.

Chemical Operations of Color Manufacture

Nitration is perhaps the most frequent of all the operations involved in color manufacture, as well as the fundamental reaction in transforming coal-tar crudes into high explosives. An aromatic compound is sub-

(*Continued on page 49*)



Opening of a filter press at the end of an operation—the colors are removed in the form of pasty cakes

Grinding the completed and dried dyes into powder—the final step before packing for shipment

The Submarine Problem—VIII.

What the Airmen Can Do in the Hunt for the Elusive U-boats

THAT the U-boat hunt should at all be conducted from the skies is indeed an anomaly; yet on numerous occasions it has been demonstrated that submarine craft are more susceptible to aerial methods than to surface and sub-surface craft and devices. This does not imply that aircraft are the sole solution of the problem; far from it, aircraft are but a means to an end. Alone, they would not suffice. But in combination with the other methods already in use they complete the anti-submarine campaign—round it out, as it were.

Aircraft can and are participating in the two main phases of the anti-submarine campaign: the detection of the U-boats and their destruction. As a general thing, however, the aeronautical activities are limited to the former phase, since the latter can best be accomplished by the usual surface and sub-surface means, despite the fact that there are not a few instances in the present war of the destruction of submarines by means of aerial bombs.

Exceptional visibility is the main reason for the use of aircraft in the present campaign against the German sub-sea blockaders. Although periscopes can be sighted from a position near the surface with considerable difficulty, owing to their small size and clever camouflage, as well as the refraction of light from the surface, at a height of several hundred feet they stand out more or less prominently against the mass of water. Usually it is the foam in the wake of the submarine's periscope that betrays its position to the airmen, and the best time for aerial patrols is therefore limited to clear weather and calm seas. During stormy weather it is difficult, if not impossible, for an observer to detect a periscope because of the broken water on the surface. However, this drawback is more or less counterbalanced by the fact that rough weather is not favorable to submarine operation. The sighting range naturally increases with the altitude of the observer; but the altitude, in turn, is limited by the sharpness of vision of the observer. Special optical instruments are used to some extent to improve the vision of the airmen at great heights, and these instruments are especially suited to seeing objects under water.

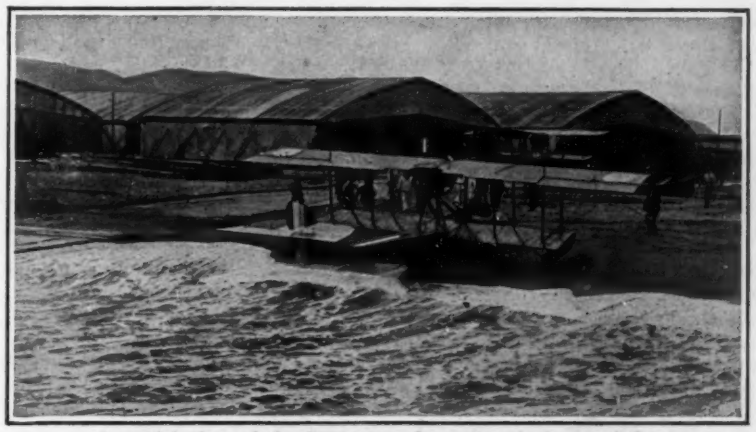
Aside from the wide range of vision, the observer in the skies is able to see for some distance below the surface of the water under favorable conditions. But too much faith has been placed in this fact by the laity, and too much is expected of this possibility of aerial observation. True, in clear weather an aviator, from an altitude of 1,000 to 3,000 feet, can make out the general shape of a submarine down to a depth of 100 feet. This is the extreme range of vision—under *ideal* conditions. In stormy and cloudy weather the vision is reduced to 20 or 30 feet below the surface, and under still more adverse conditions the vision is limited to the surface. Upon the condition of the surface, the nature of the ocean bottom, and the condition of the skies depends the range of vision through water. In the North Sea, where the water is a kind of leaden gray in color, vision through the water is almost impossible and 10 feet of water over the periscope is sufficient effectively to hide the U-boat. So in the long run the aerial observer must rely on the foamy wake of the periscope and superstructure of the U-boat, nothing else.

Kites, captive balloons, seaplanes and small dirigibles can and are being used to good advantage in the U-boat hunt. The seaplanes can be either of the fast, scout type, or the heavier reconnaissance and bombing type. Although the seaplane is somewhat handicapped by the fact that it cannot stop in the air and hover over a given spot, it has the advantages of high speed and climbing ability, which make it ideal for covering the immense areas over which the submarine hunt takes place. Furthermore, while the majority of U-boats are ill-equipped to combat troublesome aircraft, those that are equipped with anti-aircraft artillery, particularly machine guns, stand small chance of hitting the fast-moving seaplane, especially since the submarine deck is anything but a steady gun platform.

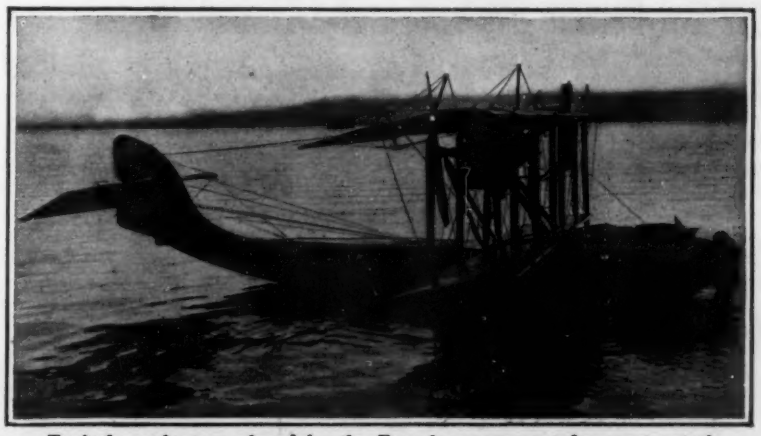
A speedy seaplane can cover a remarkably big area during a single trip, and at a height of 7,000 or 8,000 feet its observer is able to command a view for miles around while the craft is difficult to see by those below. Indeed, while it is well known that an aeroplane can be heard for some distance off on land, on water the lapping of the waves and the whistling of the wind through the rigging and superstructure of a vessel make it almost impossible to hear the power plant of an approaching seaplane until it is almost overhead. Hence the submarine plying the surface has slight warning of an impending seaplane attack until it is often too late to escape.

Of late the Allies have resorted to the use of small dirigibles, which are known as "Submarine Scouts" or "Blimps" by the British. These diminutive dirigibles are really a cross between the aeroplane and the dirigible, being provided with a small gas bag and an aeroplane body and power plant. Although slower in speed than the usual seaplane, these dirigibles have proved excellent in coast patrol work. They have a cruising radius of several hundred miles, and are equipped with bomb-dropping devices and wireless apparatus. The main advantage of the dirigible, in this instance, is that it can sail through the air at any desired speed within its range, and stop and hover over any suspicious spot to await the reappearance of its submerged prey. The seaplane, in contradistinction, must continue to fly at a high rate of speed, and the best it can do is to fly in circles or figure eights about a given spot.

Captive balloons are used to a large extent in harbor protection; in fact, most of the French ports are provided with captive balloons in which observers scan the sea for miles around in their watch for lurking U-boats, as well as hidden mines. In the latter connection it is well to add that the seaplanes and dirigibles also perform the function of indicating mines and other dangers to mine sweepers, and in this way greatly enhance the value of their services. Kites, it appears, have not been used to any appreciable extent, although they have been recommended for use on merchant ships and even war vessels as a means of elevating an observer several hundred feet into the air, instead of placing him in the usual crow's nest where the visibility for submarine detection is rather limited.



A partial view of the hangars and seaplanes of one of the French aerial patrol stations



Typical seaplane employed by the French government for coast patrol duty. This machine carries a pilot and an observer

Aircraft are used more in the rôle of detectors than destroyers. Although many of them, particularly the heavier seaplanes and the dirigibles, are equipped with bombing apparatus and light guns, the inaccuracy of the former and the light caliber of the latter have somewhat limited the powers of aircraft as offensive weapons against U-boats. Nevertheless, it is understood that many excellent types of submarine bombs and grenades have been introduced, and whenever a seaplane or dirigible has been able to approach to within a few hundred feet of an underwater raider the results have been extremely unfortunate for the latter. Some of the missiles employed are designed to penetrate some distance down before exploding under water, so that even if a direct hit is not scored the force of the explosion reaches the submarine in sufficient degree to make it most unpleasant for the crew, let along impairing or disarranging part of the equipment.

But the main function of aircraft is to coöperate with the usual surface craft, signaling to them by means of wireless, smoke bombs or rockets whenever an enemy is detected. The surface craft, in turn, have usually little trouble in following the enemy with the aid of the aerial observer; and if the chase is continued long enough the result is generally one less submarine to contend with. In convoying vessels, aircraft are almost indispensable if the greatest degree of safety is sought; for the aerial observers are able to detect U-boats long before they would be seen by those below.

It has been suggested, and it is rumored that the plan has already been carried out in a modest way, to maintain an aerial patrol along the routes followed by shipping, the seaplanes and dirigibles taking their supplies of bombs and fuel from mother ships of the class officially known as "seaplane carriers." With hundreds of aircraft constantly in the air and covering a wide expanse of water while coöperating with the usual surface craft, it should be possible to make it extremely dangerous for any U-boat to show itself above the surface during daylight; and at night large seaplanes equipped with searchlights could make it almost as dangerous for submarines to rest on the surface while charging their batteries. An English authority has suggested that one seaplane carrier with half a dozen seaplanes, carrying bombs and perhaps light armament, should be capable of acting as convoy for a flotilla of half a dozen ocean-going tramp steamers through the submarine zone.

Were it not for the increased thickness of the armor carried by German submarines, a light-weight cannon of 1½ or even 3-inch caliber could be used to good effect, but at the present stage of the campaign such artillery would prove of little value against the latest U-boats. At any rate, the fear of bombs is sufficient to make a U-boat stay under cover and use its limited store of torpedoes against intended victims.

All in all, aircraft can be considered as valuable accessories in the present U-boat hunt, and it is possible that improved bombs may yet make them major weapons.

Invar

THE fact that all metals expand and contract more or less with every variation of temperature introduces great complications into the making of instruments concerned with absolute standards of time or space, and much research has been devoted to the finding of a metal having the lowest possible coëfficient of thermal expansion. In due course the investigators arrived at a nickel steel alloy containing about 36 per cent nickel and about 5 per cent each of carbon and manganese, which was found to have a remarkably small thermal expansion at ordinary temperatures, and to which the name "Invar" has been given.

A summary of the results obtained during the last twenty-five years by various investigators of this property of invar and related nickel steels show that a bar or ordinary invar expands or contracts by about one-millionth of its length for one degree centigrade alteration in the temperature anywhere within the range of zero to forty degrees. A much higher degree of constancy than this is, however, sometimes obtained; much depends on the amounts of carbons and manganese present. Small quantities of invar have been manufactured which showed a change in length of less than half a millionth per degree between zero and twenty degrees. This alloy contained .06 per cent carbon and 9.39 per cent manganese. Samples have even been prepared which showed a negative coëfficient of expansion, *i.e.*, which contracted slightly instead of expanding as the temperature rose.

Invar possesses this peculiar property only within a moderate temperature range; from forty degrees upward the coëfficient of expansion steadily increases as the temperature rises, until at two hundred degrees, it is almost the same as that of Bessemer steel. Like certain other alloys, invar gradually elongates with time, and when it is used on a length standard a periodic correction has to be made to allow for this. The effect may, however, be largely diminished by prolonged heat treatment prior to finishing.

Doing Our Bit—III.

Government Control of Shipping

IN the previous articles it has been pointed out that Government control of shipping is an essential to adequately meeting the submarine problem. Under Government control, the merchant marine, through its centralized direction, will have advantage of all available sources of information and the services of the various advisory committees comprising the best brains of the country in their own particular lines.

The first step toward getting the greatest number of ships into the war-zone carrying trade would be an inventory of all available American bottoms. Our ships comprise large transatlantic liners, large coastwise liners, smaller coastwise freight ships, sailing craft, big deep-water barges and smaller barges of the box or scow type. These must all be carefully listed, with their capacities and the work for which they are best suited. The next step would be to decide upon the routes which must be maintained and the amount of tonnage to be moved monthly along each route and the essential variation for each class of freight. By close coöperation and centralization it would be possible to divert tonnage from route to route as the need arose in one line and fell in another.

On all routes the type of carrier must be that fitted for the work and the least capable of being used in a more arduous service. In other words, all our vessels must be promoted. Schooners and off-shore barges must relieve the smaller coastwise steamers. Then the latter must take the place of the larger steamers, and these in turn must graduate into ocean work.

All this must be accomplished without affecting the supply of food, fuel or other vital staples which require movement by water. It is a job for big traffic men and can be handled only by such. With a number of dispatchers along the seaboard in intimate touch with the National Trade Council and the Council for National Defense, and through them with conditions and needs, the question of freight congestion and the problem of securing an adequate supply of coal to the New England manufacturers will be assured of proper handling.

Next to the job of getting the maximum possible number of ships into the transatlantic trade comes the task of making each ship do the greatest amount of work. Increasing the speed of ships, that is, decreasing the time required to make a round trip, results in an increase in the number of round trips each ship can make, which is the same as increasing the number of ships.

If all shipping is under Government control, any ship may be docked wherever wharves are vacant and suitable for the receipt of her freight, instead of having to wait for a particular berth. Ships operated by the Federal Government will not be subject to many of the delays at present imposed upon commercial ships, such as quarantine inspection, war-time harbor regulations, and pilotage rules.

As the ships will be run to win the war and not to pay dividends, they can carry a larger crew. This will permit more men in the fireroom to make the speed, more men on deck to keep a lookout, more men everywhere to maintain the ship in good condition.

Anything which would help defend the ship from attack would be supplied regardless of its cost. Higher powered radio sets or any late developments in microphones or other complex installments would be fitted wherever their use would be of value.

Instead of using the cheapest coal that came to hand, the ships would be supplied with the highest standard of Navy coal. This coal would be fired by men trained in its use, and under such conditions should increase the speed of any ship from five to ten per cent. With scientific firing and with a large enough fireroom force to keep all tubes clear, the chance of "torching" on a dark night in the danger zone would be reduced.

Another reduction in the round trip time would be accomplished under Government control by the lessening of the time consumed alongside a wharf in coaling, loading and overhauling. The large crews carried on deck, on account of the vessel's battery, would permit each ship to undertake all her own stowing and stevedoring in port, besides keeping up the ship's work. Coaling in out-of-the-way places would be expedited by a crew which would take it on Navy fashion, making every coaling a race against time.

Of course, a large number of the men taken from the Navy for the freight ships would have to be trained in the particular duties of such service. One especial demand would be for trained helmsmen, and the rapid perfection of three or four quartermasters for each ship would be a difficult proposition. In addition to such training all men detailed for duty on the armed cargo ships should be thoroughly qualified lifeboat men.

The young Americans who have enlisted in our Navy will not at first take kindly to the idea of being placed on board what will appear to them to be rusty and prosaic old tramps. Only by showing the people of the country that the cargo ships are the ones on which the outcome of the war hinges, that the cargo ships are nothing less than men-of-war carrying freight for the Government, and that they are probably the only men-of-war, outside of the destroyer flotilla, that will see active service, can this duty be made attractive.

When the crews realize that in manning a freight ship carrying munitions to our armies in France, they are performing work exactly comparable to that of a driver of a truck bringing up shells to the firing line, there will be no objections raised to this duty. When it is further shown them that an efficient merchant ship will possibly go in for a little submarine hunting on her own account if she sees a periscope, they will clamor for a chance to go.

The same ideas must be spread among the officers who will operate the vessels. Our merchant marine officers, capable men along their own lines, have failed to accommodate themselves to the changed conditions which the U-boats have imposed upon us. Ships have been lost because their commanders failed to carry out confidential instructions given them on the ground that all such was "Government foolishness." For the simple reason that they had always crossed that way, some masters have taken their ships across along the established sea-lanes where submarines would look for them rather than by the secret Admiralty routes.

On the other hand the British Admiralty has been frequently to blame for issuing orders which were impossible of execution. There has been a marked need for coöperation between the fighting service and the Merchant Marine. Merchant officers have been placed in the position of having to combat an enemy with whom they were unfamiliar and against whom their means of defense were meager. Great Britain has realized this fact by establishing a school for officers of the merchant service, where they are made familiar with the appearance of a submarine under various conditions, the limitations of the boat itself and of its weapons, and how best to ward off its attack.

If it is to save its ships and carry its troops abroad, this country must come to some such intelligent policy. The merchant-marine officer must be given a fair chance, not sent out blindfolded. If all our ships were manned by Naval Reserve officers it would be possible to give each officer a brief course at a submarine base on the subject of the U-boat, and supplement this with an outline of gunnery training so that regular Navy officers would not have to be taken from the battleships for duty with the gun-crews.

Some officers, regularly commissioned and uniformed, would have a status which although it might not prevent the gentle Teuton from pistoling them, would at least remove the last vestige of justification. As was desired by the German war staff, the fear of being treated as a pirate is ever-present among the officers of our merchant vessels, and a certain amount of consolation would be derived by the feeling, in case the threat should be carried out, that at least one perished as a martyr and not as a plain and simple fool.

The same official status which might serve to stay the hand of the Boche would be also of advantage in moderating the harsh voice of the midshipman afloat in a patrol vessel. When a captain has served years in a big passenger line and has always been looked up to by his crew and his human cargo, it does not sit well upon his dignity to have a youngster in a motor boat order him around brusquely, even though he is perfectly willing to obey the orders. Then, as Naval courts-martial are fearsome things, there would be a very tangible hold on the captain in case he did *not* obey the orders, just as there would be on the disrespectful patrolling officer.

Humans are much the same everywhere, and if officers of the merchant service were recognized as an important part of the military forces of the country, and if one tithe of the fuss that is made over our soldiers and our sailors abroad were expended on these men who have just as surely risked their lives in performing equally important services, there would be much less heard of the shortage of officers in the Merchant Marine.

Infantile Paralysis

By John B. Huber, A.M., M.D.

INFANTILE paralysis is that infection which so grievously visited the metropolis a year ago and which, it is feared, may this summer show itself in epidemic form in other parts of the country. A brief resumé of its manifestations and of the latest authoritative beliefs concerning this acute anterior poliomyelitis, as physicians term the disease, is therefore in order.

We have here to deal with a germ disease; the germ has been discovered by Dr. Simon Flexner of the Rockefeller Institute in New York, who describes it as a minute filtrable virus which he has secured in artificial culture and which as such is distinctly visible under the higher powers of the microscope.

This virus invades the cerebral nervous system and exists constantly in the central nervous organs, also upon the mucous membrane of the nose and throat and intestines of infantile paralysis sufferers. It is considered to reach the intestinal tract by reason of the germ-laden sputum which little children are so prone to swallow. Although many physicians have earnestly sought and are still seeking an antitoxin which will be at once preventive and curative, no antitoxin that has with any measurable degree of certainty been proved effective has yet been developed. There is, however, every reason to be sanguine that such a serum will be forthcoming.

The incubation or hatching period of infantile paralysis is anywhere from two days to three weeks; but most cases develop within eight days of exposure to the infection. Then comes the invasion—fever, vomiting, convulsions, pain in the head, neck and back, sudden paralysis of one or more limbs or muscle groups, followed by rapid wasting of the affected parts. Although youth and adult life may be affected, the disease occurs mostly in the first three years of life, and in the summer time. "The first frost kills it."

The virus enters the body by way of the nose and throat—about as do those of diphtheria, scarlet fever, and measles. It is carried from the sick to the well on handkerchiefs, towels, and the like; and there are those who, like "Typhoid Mary," though themselves manifesting none of the symptoms of the disease, are yet potential carriers of the virus to others who may, by such infection conveyance, become stricken. Though there is as yet no specific, no surely curative agency, much is accomplished by rest in bed, diet, sponging, ice-packs along the spine from the back of the neck down, medicines addressed to the fever, the pain and other symptoms, with electricity, massage, and other passive motions after, *and only after*, the acute symptoms have subsided. Even so, more than half of those who recover suffer afterward from paralysis.

Patients with infantile paralysis must be isolated, either in their homes or, better, in hospitals. The severity of epidemics fluctuates widely, as does also the mortality—anywhere from five to twenty per cent. In those who recover the affected muscles are likely to remain small, and perhaps throughout there may also be retarded bone growth, deformity, poor circulation, and an impaired constitution. Fortunately, however, the mentality rarely suffers.

In the presence of an epidemic, it is of the utmost consequence that the general, constitutional health be maintained at the highest possible standard; for only the predisposed are likely to become sick. The most important additional and local preventive measure is gargling with a normal salt solution, a half teaspoonful of table salt to a tumbler of water as hot as can be comfortably borne. The nose should also be irrigated with this solution, by means of a nose cup or an ordinary medicine dropper.

Among the procedures and regulations adopted in June of this year by the Health Department of New York city—in harmony with the suggestions made by the recent Conference of the State and Provincial Boards of Health—are the following:

Children who have been, but are no longer, exposed to the poliomyelitis infection will be quarantined for 14 days from the date of the last exposure. The sick child is to be isolated for three weeks from the date of the onset of the disease, and is then released provided there is no fever and provided discharges from nose and throat have ceased. Adults of the household, if the patient is isolated at home, may continue their vocations provided this does not bring them in contact with children under sixteen years of age, and provided also such workers are not engaged in the preparation or handling of food. Physicians, nurses and other attendants upon the sick child must use every precaution against being soiled by discharges and droplet infection, and their hands must be thoroughly cleansed with soap and hot water before leaving the sufferer's room.

Patients may remain at home only when the following conditions are complied with: A family doctor must be in frequent attendance. The patient and the nurses or other attendants must have a room or rooms separate from the rest of the family. All the windows of the sick room must be screened, and all flies (which may be carriers of the virus) that are in the room must be killed. Isolation and quarantine regulations must be faithfully observed by the family in general. All discharges from the patient's nose, throat and bowels, and all articles that may have come in contact with such discharges, must be promptly disinfected, as also all eating utensils and personal and bed clothing. The patient's attendant must do no housework or marketing; she may, however leave the house provided the necessary precautions as to personal disinfection are observed and, especially, all children avoided.

Correspondence

[The editors are not responsible for statements made in the correspondence column. Anonymous communications cannot be considered, but the names of correspondents will be withheld when so desired.]

Spelling Proper Names

To the Editor of the SCIENTIFIC AMERICAN:

I noticed in your editorial columns a few weeks ago an article under the heading, "proper names in newspapers." The editor lamented the many and glaring errors, especially in the spelling of proper names. Permit me to give an explanation, and one which I believe is the true one, in a large percentage of these errors.

As a practical compositor of many years' standing, both in the old "hand-set" days, and in later years on machines, I have noticed a peculiar perversity on the part of many writers to form carelessly the letters in proper names. They apparently act on the supposition that the compositor is as familiar with the name as they are. Almost any word (excepting a proper name) in an ordinary sentence, can be deciphered no matter how slovenly it may be written, from the context—the words preceding and following, but with a proper name the words in conjunction with it seldom afford any clue. Hence the spelling is guessed at, and frequently guessed wrongly.

WALTER PETERS.

Peterboro', Canada.

Springfield vs. Enfield

To the Editor of the SCIENTIFIC AMERICAN:

In your May issue I read an article on the problem of arming our expeditionary forces to France. It stated that it would be wise to use the British Enfield, rechambered for our Springfield 1906 cartridge.

I can't help believing that this must be an error. If we are to use the British rifle because we are equipped to manufacture it faster than our own, why chamber it for American shells? My point is this: If we should find our supply ships torpedoed our forces could use English amunition, and replace it as soon as we got a shipload through to Europe.

It seems reasonable that much difficulty would also be avoided if coöperating forces of English and American troops did not need to keep their ammunition separate.

You know the superiority of our 1903 Springfield in weight and power, and though rifles now are comparatively ineffective anyhow, still I think the plan mentioned would be a mistake.

PERRY DEMING.

Brooklyn, N. Y.

Another Reversion to First Principles

To the Editor of the SCIENTIFIC AMERICAN:

From the time the war in Europe settled down into the trench form, and hand grenades, cohorns, darts, Greek fire, and various other medieval weapons made their appearance, I have been looking for some mention of the use of the deadliest weapon of the eighteenth century, the smooth bore fowling piece loaded with buck shot. So far I have not found it in any reports from the war zone, nor have I found its use advised by any of the numerous strategists who are directing the war from their easy chairs.

I speak advisedly when I call it the deadliest weapon of the eighteenth century.

The military sharps of that period so recognized it, when for a period of over 100 years they used the buck and ball cartridge, and the ball of this charge, an inch in diameter, was not added to the load to kill the man but to stop the horse, a buckshot was sufficient for the former.

Bunker Hill was fought on the American side with fowling pieces and smooth bore muskets loaded with buckshot and slugs; the New Englander of that day was not a rifle shot and rifles were but little used. This was the chief reason that General Putnam had his men hold their fire until the closed ranks of the British were near at hand, not for fear they might miss, but because their killing range was short.

The result everybody knows.

As the use of the rifle became general in the armies of the world during the nineteenth century, the buckshot passed into oblivion, and has been so far forgotten by the ordnance officers of the contending armies, that it does not seem to have been resurrected along with other obsolete weapons.

My plan would be to have in every trench as permanent equipment, a magazine shot gun, loaded with buckshot, for every man, in addition to his service rifle and bayonet.

Then when the enemy leaves his trenches to make an early morning call, each defender is at once an active little machine gun operator, his magazine which he can empty in ten seconds, containing sixty buck shot, any one of which properly placed, will kill a deer at sixty yards and should account for a man at the same distance.

His magazine being empty, he can either reload or resume his service rifle and bayonet, provided the enemy has been able to stand the deadly hail of little, stinging bullets, any one of which is sufficient to cool the ambition of the average German. Especially would this be true if General Putnam's advice to aim at their belts should be followed.

Another advantage in this use of the pump gun would be that we would not have to wait to build factories for their manufacture. There are thousands in use today, practically all of the same caliber.

All that would be needed would be for the ammunition factories to speed up in the production of the regular 12 gr. buckshot cartridge; the guns could be purchased, commandeered or donated in sufficient quantities to arm all our forces that may be sent to France.

J. L. TRAVIS.

Germantown, O.

Ships of Steel and Wood

To the Editor of the SCIENTIFIC AMERICAN:

It is our urgent desire to build ships as quickly and as fast as possible to carry supplies to our friends over the sea. We will build them of both wood and steel. Build the larger size of steel and the smaller size of wood. I would suggest building the intermediate size ships from 300 to 350 feet long, out of both wood and steel combined, using steel for the keel, stem, stern post, frames, floors, keelson and deck-beams; using wood for the planking, deck and all other purposes.

It seems to me this combination would make a stronger, better, more durable ship, with larger carrying capacity than one of all wood construction of equal length, breadth and beam without increasing the cost to any great extent if at all, and might save considerable time, owing to the lack of good, strong durable timber of suitable lengths and the slow, careful work required to get out wood frames for ships, where every piece is a sector of a circle. All this timber will have to be used green or unseasoned, which I am afraid will prove very unsatisfactory.

It may not be practical to combine steel and wood in this manner for ship building, though I think a way could be found to do so.

The ships might be planned so that if after a few years' use the planking was found to be worm eaten or leaky it could be taken off and replaced with steel plating.

This is offered as a suggestion to the Ship Building Bureau—a problem we are all deeply interested in.

JAMES M. WELCH.

St. Paul, Minn.

Tractor or Horse?

To the Editor of the SCIENTIFIC AMERICAN:

In view of the fact that there is great need for more food stuff, I would suggest the following:

That the Government be urged to put on a campaign among farmers for a wider use of tractors (with oil burners), to take the place of work animals, the object being to lessen the necessary feed crops. If a farmer raises all his feed, he must set aside at least three acres per head of stock. In other words, for every four acres that horse helps to work, one must be for himself. Any thirfty farmer can raise enough grub on the same three acres to keep up a family of five. If he can substitute a tractor for a four-horse team he can provision possibly twenty more people. Hence it appears to me that we could better serve our purpose in this war if we should quit raising so many stock and build more tractors, cut our corn and oat crops, and raise more wheat, beans, and potatoes.

OLIN M. GEER.

Puna, Texas.

The Aeroplane and the War

To the Editor of the SCIENTIFIC AMERICAN:

Is there any hope that any army of infantry, cavalry and artillery that we may be able to train and send to the battle front over in France will be able to accomplish anything substantial? Is there any chance that a million men of our country would materially affect the result when there are already 30,000,000 men, trained and armed and fighting? Would it not take 5,000,000 or 10,000,000 of our men, trained and armed, to make any material impression?

Is it not true that this war must be fought out on lines different from any struggle in past? Is it not a fact that it has been demonstrated on the battle front that neither side is able to conquer the other side in the old style of men and gun fighting?

The other side discovered this long ago and brought out the submarine which is today the greatest factor in the war as measured for success or defeat.

Now, it is our time to bring out something that will set a new standard in winning battles. It will be frightful, all right, and ruthless too, but the other side has set us an example of frightfulness and ruthlessness that knows no measure, so we have precedent which we may properly follow.

The best, cheapest and quickest way for us to win this fight is to make 100,000 aeroplanes in the next six months, or three months and send them to the front, properly manned for business and properly equipped to bring the enemy to terms. If we could drop a million bombs each day, from air ships, onto the enemy's armies and cities and supply bases, it would be only a matter of days, until we would have a peace offer that we could afford to consider.

Can we do it? Our automobile factories can make 1,000 cars per day. Just give them plans and patterns and they will turn out 1,000 planes each day. Ask for volunteers to man them and you will get them as fast as can be used. Send them to the front and the war will be won. Yes, it will be won by ruthlessness all right; but that is the only way it will ever be won, so why not go at it now and without delay. Time is the essence of every transaction. If we can do this quickly, it will succeed. If we dally and delay and put off and finally get there too late—but let us not consider that. Let us push it to a finish now.

C. T. S.

Georgia.

Famine Prices for Wheat

To the Editor of the SCIENTIFIC AMERICAN:

A recent article drew attention to the possibility of a world famine following the world war. It may be profitable to make some investigation into the question whether a state of famine does not already exist.

It is common error to suppose that there can be no state of famine without bread lines, soup kitchens, and other physical manifestations of hunger. As a matter of fact, bread lines and soup kitchens do not necessarily bear any relation to the world's supply of food, or even to the food resources of the city or country which is obliged to adopt such means to feed a portion of its population. Soup kitchens are an evidence of scarcity of employment rather than scarcity of food, and the war has brought about a situation in the labor world as remarkable as that which prevails in the matter of food supplies, and the one, on the surface, appears to neutralize the other. Scarcity of food has forced the price to levels unknown since steam transportation made the resources of one country available to another, but scarcity of labor, and the impetus given to business by war expenditures, have made it possible for the masses, as yet, to pay the price. The general prosperity which enables the public to pay high prices for food should not be allowed to disguise the fact that food prices are high, abnormally high; that high prices are an evidence of scarcity, and that scarcity, unless relieved, spells famine.

It must be apparent that wheat at two dollars a bushel has no more food value than wheat at one dollar a bushel. The increase in price is due to competitive buying, in which the family that has two dollars with which to buy a bushel of wheat gets the wheat, and the family unable to pay two dollars a bushel must do without. And no increase in price, however great, can possibly provide enough wheat for both classes of families, except by the ancient and slow process of encouraging greater production from the soil.

The fact is, that to the family which cannot afford to buy flour at five dollars and more per hundredweight, a state of famine already exists.

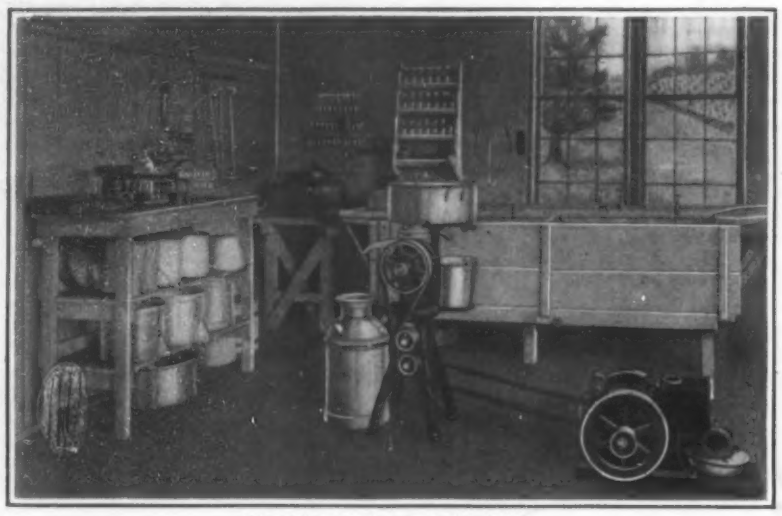
In normal times, the price of wheat bears a direct relationship to the cost of production. This relationship may be lost sight of owing to the fact that its operations are apparent only when viewed over a period of years, but it is fundamental, nevertheless. When the farmer finds his wheat fields unprofitable he gradually reorganizes his production in such a way that his time and his land can be made to give a greater return. This may be accomplished by going more extensively into fodder crops, livestock, dairying, etc. Or the same effect may be obtained by an exodus from the farms to the cities, such as is frequently noted and lamented during periods of low prices for farm production. At any rate, the economic law is not mocked, and the relative product falls off during a period of years until the resultant shortage causes an advance in wheat prices and the reverse process sets in.

EARLE WILLIAM GAGE.

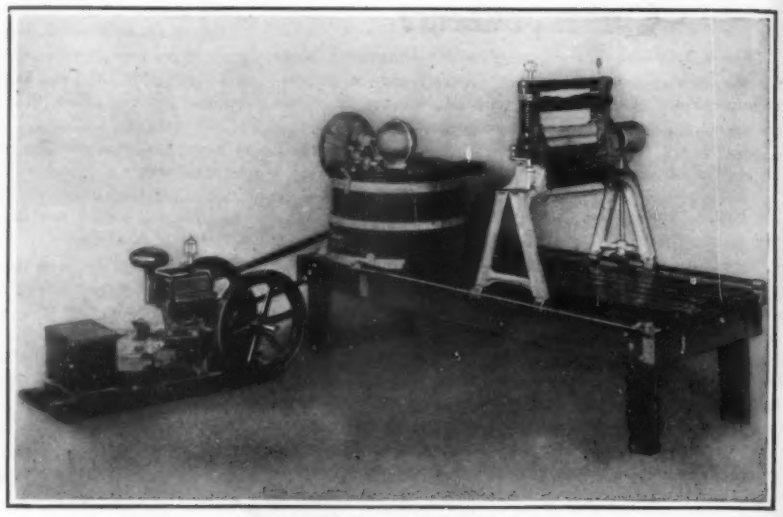
Ashville, N. Y.

The Heavens for July

Too late for earlier correction our attention is drawn to the fact that our printer, in making up the astronomical page for our issue of June 30th, used the wrong map. Doubtless the more sophisticated readers of this page have remedied the error by turning back to the June map and making the appropriate time allowances. To those who did not find themselves able to do this, and who were baffled in the attempt to reconcile our November map with the July skies, we extend our sincere apologies.



The kitchen of a motorized farm



The twentieth century wash day

Internal Combustion Engines for Farm Use

Horse-Power and Other Technical Matters Translated Into Terms of Farm Work

By Victor W. Page, M.S., A.E.

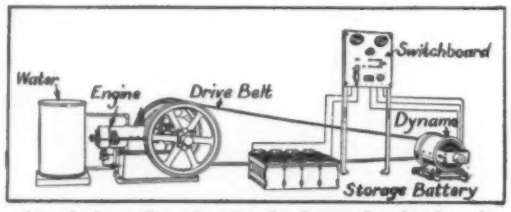
IT has been stated that more power is needed to carry on the farming operations necessary to feed the population of the United States than is required in all the manufacturing establishments of the country. Just as man-power was long ago practically dispensed with in our industrial plants and replaced by the more economical machinery, so the modern farmer is using mechanical power to the exclusion of hand labor wherever possible. Modern farming is in fact an industry, and the farmer has advanced from the easily met condition of just making his own living to the more important work of being the directing force that must supply food and other necessities for a greater number than his own family. It will then be evident that the same economic arguments that call for the use of power-operated machinery in the factory render it of equal importance on the farm.

Power of various kinds has been used by the farmer in the past, but before the introduction of the internal combustion engine the various power-producing devices available either depended on uncertain natural forces such as wind or water, or were a clumsy and inefficient means of utilizing the power of some farm animal. Steam power, which is so successful in its many industrial applications, is far from an ideal farm power. A steam plant, with its auxiliaries, is not easily moved unless mounted on a tractor; and when of any considerable capacity it calls for the services of an experienced engineer.

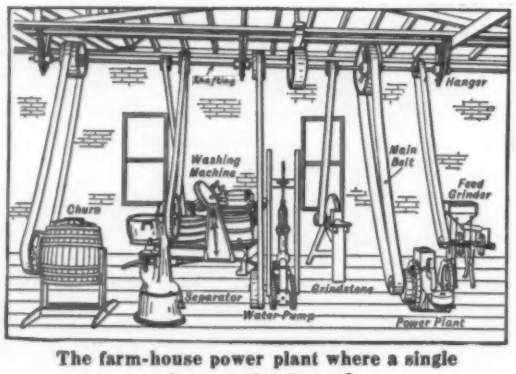
The farmer's tasks are many and varied. Much of his work is done in relatively short periods and at many different points on the farm. An ideal power producer for his use must essentially be easy to run and easy to move. It should not entail any maintenance expense except when actually in use, and it must be ready for any task at short notice. Its action should not be easily disturbed by unfavorable weather; it must be operated at any time and any point, indoors or out. Needless to say, it must be safe and reliable, as well as economical. The internal combustion engine using gasoline or kerosene for fuel is the only power available at the present time that meets these exacting demands. The same form of prime mover that, because of its compactness and efficiency, has made possible the aeroplane, the automobile, the motorcycle and the submarine, is the one best adapted to furnishing power for farm tasks.

An internal combustion engine, in its simplest form, can be mastered by any person having the slightest knowledge of mechanics. The number of vehicles propelled by the internal combustion engine that are being driven over our highways by mechanically inexperienced operators must prove that its reliability and safety can hardly be questioned. The work this engine is doing on the farm, however, is apt to be judged by the spectacular performances. We are all familiar with the pictures showing how a gas tractor can do plowing, harrowing and seeding all in one operation, working in terms of square miles rather than of acres. Its work in harvesting and threshing is equally well known. But the use of the gas engine in such work as irrigating fields and spraying orchards is not so widely recognized, because it is not spectacular. Many people have but little conception of the way it enters into the every-day life of the farm. Digging post holes, cutting wood, turning the grindstone, cutting feed, are humdrum tasks; but they are performed far more often than plowing, seeding and harrowing.

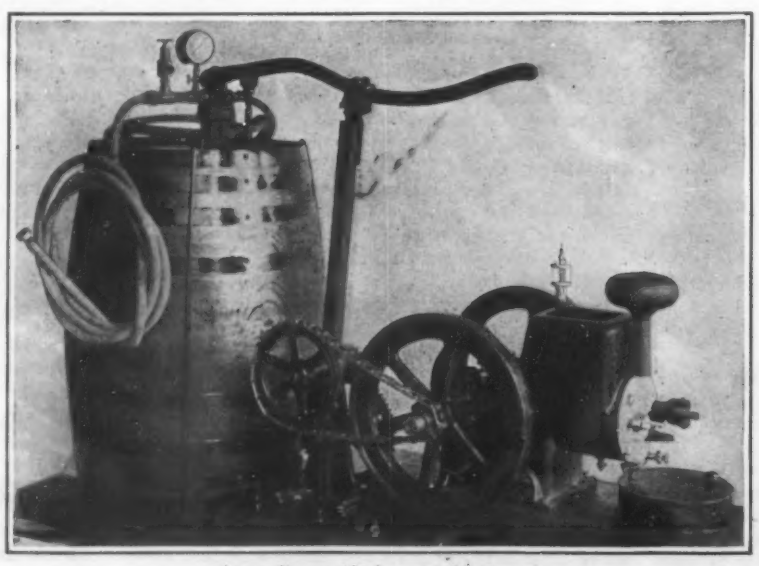
All farms do not need the gas tractor; but the every-day humble tasks must be performed on the small farm as well as on the large one. As the gasoline or kerosene engine may be obtained in any size from a quarter horse-power up, it is evident that there is no work requiring power for which it is not fitted. Most of the labor saving implements and machinery of the farmer are intended for field use. The gasoline engine is the notable exception. It can be used by the women of the household as well as the men. It will run a washing machine or turn a wringer. It will pump water from the well, do the churning, run the cream separator. By the aid of simple attachments it can be made to sweep the floor, remove the dust from the carpets and hangings, wash the windows, even lighten the drudgery of washing dishes. Its use in the automobile brings the farmer closer to his market and provides a source of recreation that cannot be surpassed. It not only makes the farm tasks lighter but makes the farm home more livable and provides many of the comforts, such as running water and electric light, that are usually associated only with city residences.



A typical small engine for the farm, showing how it may be used to provide electric light



The farm-house power plant where a single large engine is used



A gasoline outfit for spraying trees

The important point in selecting an internal combustion engine for farm use is the character of the work that it is expected to do. Gasoline engines for stationary work may be obtained in two types, that using vertical cylinders and that in which the cylinder is horizontally disposed. A horizontal engine occupies more floor space than a vertical one and is not so well adapted for high-speed work—the vibration introduced by the moving parts is more noticeable when they reciprocate in a horizontal plane. Because of its broader base, however, it is firmer under a heavy belt pull than the vertical type, and is therefore preferable when used in sizes above six horse-power. For the smaller engines intended to be easily portable, such as are needed for doing odd jobs around house and barn, the upright design has the advantage of lighter weight for a given capacity. On small farms, every requirement may be met with such an engine, of relatively low power. One delivering about 1½ horse-power is extremely economical, running at full load on about a quart of gasoline per hour.

For large farms two or more engines are necessary, one of sufficient power to do the heavy work of threshing, baling, wood sawing, etc., and a small engine for performing the lighter tasks enumerated above. Under such circumstances the small engine may well be of vertical type, and the only decision of moment which the purchaser has to make is that with regard to the cooling system. The simplest form is the engine provided with the air cooling flanges. This is seldom built larger than three or four horse-power, because of difficulties which begin to be serious when the cylinder bore exceeds four inches. The hopper type, in which a combined water container and cooling jacket surrounds the cylinder, is very satisfactory for engines of moderate power. It is not quite so simple, because the hopper must be kept filled. The alternative is the forced circulation type, in which the cooling fluid is driven through a pipe system by a pump operated by the engine itself. Here, one filling of the fuel container, oiler and water tank usually suffices for an extended period of operation.

Nearly all farm engines use gasoline for fuel and are of the governed type. That is to say, an engine-driven centrifugal governor prevents overspeeding and makes for a uniform number of revolutions per unit of time, no matter what the load. This is accomplished by interrupting the ignition, tripping an exhaust valve, or throttling down the gas supply when the crankshaft speed begins to exceed a certain predetermined figure. A governed engine

is necessary under a fluctuating load, otherwise the engine would speed up unduly when running under light loads.

Small engines may be easily installed on simple wheel-stands so that they can be readily moved from place to place. A two-wheel hand truck is satisfactory for handling the small 1½-horse-power air-cooled engine. Heavier engines call for a four-wheel truck, with a tongue for steering. One man can easily handle a three-horse-power engine on a truck of this sort. The heavier engines may also be supported by wheel trucks, but in most cases these must be horse-drawn. Outfits have been contrived in which the engine is made self-propelling by the addition of a clutch and chain or gear connection with the rear wheels.

A gasoline back-filler, for farm or highway work

Typical forms of horizontal gasoline engine for farm work are shown in some of our cuts. Engines of these patterns may be obtained in any desired horse-power and are the regular stationary design that has received such wide application for general shop power purposes. The power plant is carried by very heavy skids, shod with strips of steel, and provided with rings at the sides for attaching chains by which the engine may be moved. An engine of this type is not, however, intended to be moved about from job to job as freely as the engines of less power. While portable to a degree, it is best adapted to those tasks where it can be securely fastened in a position which it will be likely to hold for a time. Sometimes these engines are even mounted on a permanent base.

The power required for various tasks varies widely. Most of the work around the house, in the dairy, or in the farm workshop, can be done by a two-horse-power engine. Such an engine will pump water in moderate quantities, furnish power for washing machine and wringer, operate the churn and separator, run a vacuum cleaning outfit, a lathe, drill-press, grindstone, emery wheel or small rip or cross-cut saw, supply running water, and spray trees. In connection with a suitable storage battery and dynamo it will furnish enough electric energy to light all the farm buildings. A three- to five-horse-power engine will be all that is needed for heavy wood-sawing, grinding feed, running a large stalk-cutter, elevating hay and grain, and pumping enough water for all the live stock of a large farm. Eight- or ten-horse-power will do practically all the heavy work that an engine can do on the farm.

Of course, a large engine can be used to do a big variety of work if it is belted to a line shaft and the lighter machines grouped in such a way that they may be run off the common source of power. We illustrate a typical arrangement of this kind. Obviously, where it is frequently desired to operate separately one of the units, this arrangement is a good deal like bringing up a battery of heavy artillery to execute a spy. When an engine is used for shop power, the best practice is to install it in a separate fireproof compartment. This not only reduces the fire risk, but is more desirable in that the room containing the machinery can be kept cleaner than if the engine were there.

In irrigation work the engine power required depends entirely upon the amount of water needed. It is estimated that about six inches' depth of water is necessary for the thorough irrigation of land having average absorbing power. Since one inch of water per acre weighs over a hundred tons, it will be seen that the power requirements are considerable. Centrifugal pumps are usually employed where the lift is not excessive, while deep-well pumps are generally of the plunger type. Pump outfits used to lift water from a well to a tank, where it is stored under sufficient pressure so that it will run to all rooms of the house, are always of the plunger type. Spraying outfits also use piston pumps. A 15-horse-power pumping outfit operating a centrifugal pump will irrigate about fourteen acres per working day of ten hours. An engine used for spraying need not be of very high power, the ordinary outfit operating satisfactorily with an engine of two horse-power. This makes air-cooled spraying outfits practicable.

The water storage system that is most popular for farm use at the present time is the pressure tank, which is a large iron or steel tank that need not be elevated. It is much superior to the old elevated tank. Even when containing no water the tank is full of air, which is compressed as the water is forced into the tank by the engine-driven pump. The pumping usually continues until the pressure of the confined air is 30 or 40 pounds per square inch. This suffices to force the water through the distributing pipe to any part of the house. Some of the tank outfits are automatic in action. A one- or two-horse-power engine is ample for this work. A vacuum cleaner outfit that will take care of the average residence can be operated with two or three horse-power. A modification of the vacuum cleaner principle is used in large dairies for milking, thus greatly reducing labor.

The passing of the pump-handle

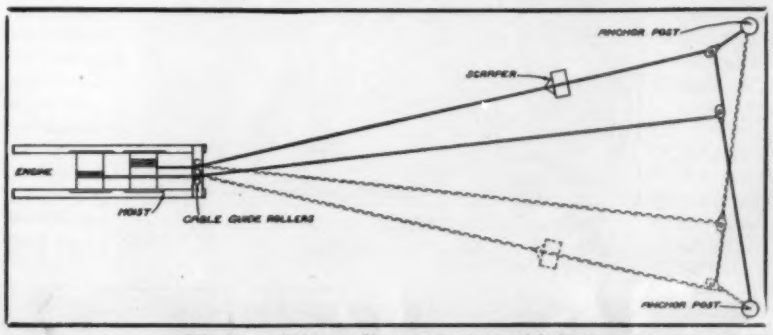
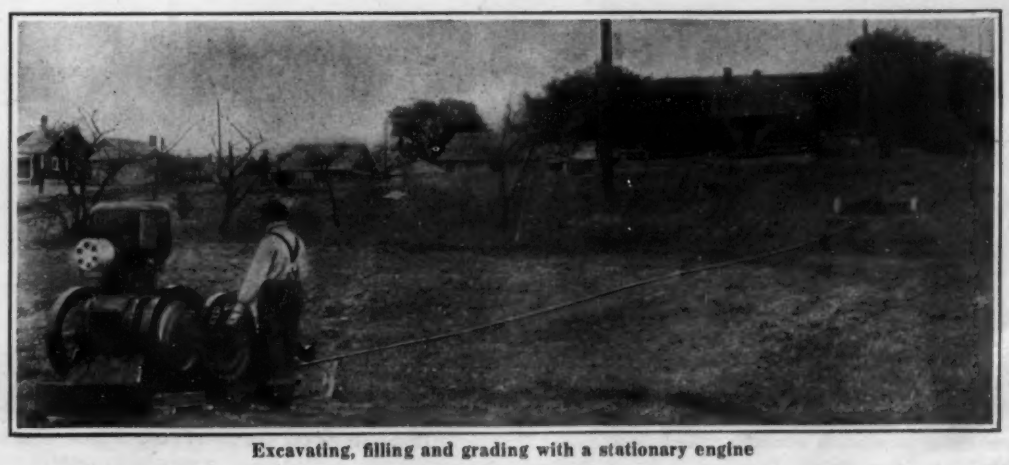


Diagram of the grading outfit pictured below



Excavating, filling and grading with a stationary engine

The cleanliness, safety and convenience of electric lighting have resulted in the installation of many isolated lighting plants on farms. While almost any properly governed gasoline engine runs smoothly enough to operate a dynamo directly without serious fluctuation of current, it is not desirable to be forced to keep the engine running at all times when lights are needed. The storage battery is far and away the best lighting system. The dynamo is driven from the engine and delivers its current to a storage battery. The wires leading to the lamps run from the battery, not from the dynamo. Compact outfits may be procured at small cost in which the gasoline engine and the dynamo it actuates are mounted together on a common base. The generator armature may then be attached directly to an extension on the engine crankshaft, guarding completely against failure of the drive. Automatic devices are combined with the outfit so that when the battery is properly charged the engine is automatically shut down. When the battery becomes discharged to a certain point, an automatic switch directs the battery current to the generator, which now becomes a motor and acts precisely as does a self-starter to set the engine going. The engine will then run until the battery is properly charged, whereupon it is again cut off. With a system of this sort, practically no attention is needed other than maintaining the supply of fuel and oil and filling the battery with distilled water to replace evaporation.

It will be evident that in a discussion of this character it is not possible to go into minute detail regarding farm engines and their uses. All one can hope to do is to show how necessary power is on the modern farm, and how well the internal combustion engine meets the situation. Where natural gas is available, the fuel problem is a simple one. Most farmers, however, have to depend upon liquid fuels, such as gasoline and kerosene. The former is more costly, but where small and medium engines are operated on odd jobs it is best, because it permits instant starting and better control of engine speed. On large engines used only for long runs a kerosene burner is a good investment, as it will insure proper engine operation on the cheaper fuel. The alcohol engine may well be the farm power of the future, but little has been done toward its development in this country.

Practically all farm engines are of the four-cycle type and the simple one- or two-cylinder forms. The fuel vaporizers are simple in design, and in many horizontal engines the space in the base is utilized for fuel storage. Battery ignition is generally favored on small outfits, because of its cheapness and simplicity. On large engines, a low tension magneto with make-and-break spark is considered more suitable. The manufacture of farm engines is an important industry and as the production is large the prices are reasonable. There is really no excuse for the farmer who does not avail himself of the advantages of modern farm power.

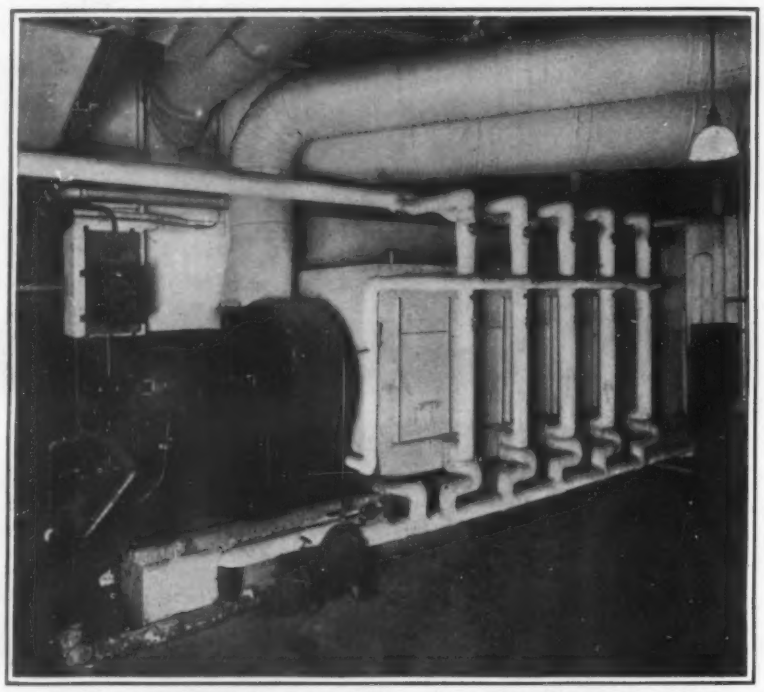
Eggs Spoiled by Wetting

ACCORDING to the U. S. Department of Agriculture, more than five million eggs spoil unnecessarily in cold storage every year because they have been washed, or have in some other way become wet, before being sent to market. Water, says the Department, removes from the shell of the egg a gelatinous covering which would otherwise help keep air and germs from entering the egg. Dirty eggs intended for cold storage should not be washed. It is found that from 17 to 22 per cent of washed eggs spoil in storage, whereas only 4 to 8 per cent of dirty eggs spoil in storage. Washing can be postponed until removal from storage just as well as not, and this should be done; or if cleaning is felt to be necessary a dry process should always be used.

Exploring the Realms of Science for Photographic Improvements

An Experimental Factory to Bridge the Gap Between the Laboratory and the Plant

THERE is a tendency in these stirring times to run headlong into new and untried ventures. The wonderful example of German progress based on coöperation of science and industry, was brought home to us by the war. We saw England awaken from her industrial lethargy and take cognizance of the value of applied science. Suddenly our manufacturers turned from an attitude of something akin to contempt for the man of science, to one of highest respect. With characteristic impetuosity they went in for scientific research. No end of new problems were born of the war and these stimulated the demand for research. As a consequence, a multitude of small research departments were established without any true conception of the nature of such exploratory work, or of the kind of men adapted to carry it on. It is now coming to be realized that it is not enough to hire a chemist or physicist fresh from college, install him in a room with a few beakers and test tubes, and then sit down and await magic results. The wait is liable to be a long one. The research man is not made in college, any more than the specialist is made in the medical school. The college is merely a preparatory school for the years of specialized study that must follow. Furthermore, the man must be possessed of a natural aptitude for such work, an attribute that may be developed but is not acquired by study.



Machinery for drying the photographic products of the laboratory showing the scale of operations in the experimental factory

It is high time that industrial research was taken more seriously in this country. The only way to arrive at a proper understanding of such work is to study some of the well established, successful, American laboratories. We have taken as an example, the research department of a concern engaged in manufacturing photographic supplies. The laboratory was not established to meet the unprecedented conditions arising from the war. Years ago it was founded under a broad-minded policy and at once proved its usefulness. When commercial conditions were upset by the present conflict it was prepared for invaluable service in making good the deficiencies of the market.

This photographic supply company which employs over ten thousand men and women, has in its research department a force of 70 men of which 40 are scientific men engaged in blazing new trails through the great unknown and in staking out new claims for future expansion.

As would naturally be expected, the instrumental equipment of this laboratory is unusually complete. Photography appeals to the eye and its standards are largely optical; consequently, much of the work is of a visual character, calling for optical instruments of precision. In fact, the principal work at this laboratory involves the use of instruments of measurement and standardization; for there must be a complete knowledge of materials produced and processes employed in order to improve them and lead to new products and methods of manufacture.

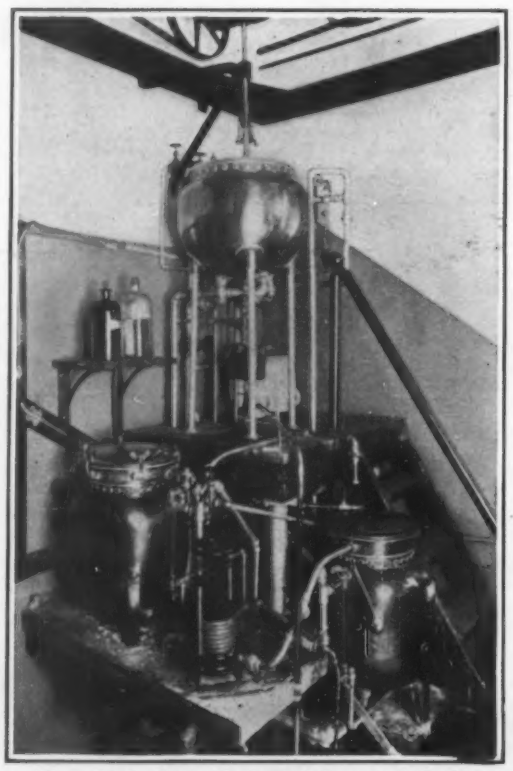
The one thing that contributed to mistrust of scientific research in bygone days was the wide gulf between laboratory experiment and practical manufacturing. It is usually quite impossible to duplicate on a manufacturing basis the wizardry of the laboratory. When the scale of operations is increased difficulties are encountered that mount up as the square and the cube, until they spell failure to the process. To bridge the gap between the laboratory and the manufacturing plant it is necessary to make experiments on a factory scale, and hence at this laboratory we find a "semi-factory" where the discoveries made with the test tube are tried out in large quantities and with the machinery and apparatus of the type that will finally be employed on a still greater scale in the main plant. This "semi-factory" is really a small manufacturing unit, quite worthy of being dignified with the title of a manufacturing plant, were it not overshadowed by the huge proportions of the main plant with which it is associated. In this research factory photographic supplies are turned out daily in fairly large quantities. The standard dry plate here produced measures eight by ten inches and is never made in smaller quantities than 75 dozen per day.

To operate the "semi-factory" calls for a permanent force of specially trained men. It will not do to call upon the regular force in the main plant because the work is not entirely of a routine character, but must be handled by men with some resourcefulness, who can be depended upon to carry out instructions in minutest detail.

Naturally much of the apparatus has to be kept in darkness. The men who operate this apparatus must be thoroughly familiar with the layout and nature of all the mechanism so as to be able to find their way about the dark rooms with the facility of a blind man. A new operative would be seriously handicapped by having to grope around, and would be absolutely valueless until he had accustomed himself to his surroundings.

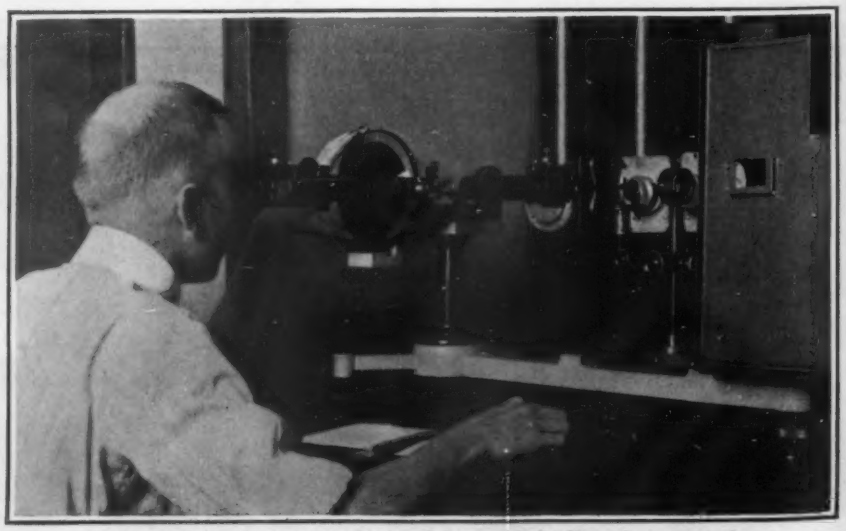
The scale upon which work is done in the "semi-factory" is illustrated by one of our pictures which shows the machinery employed for drying the photographic products of the laboratory. In order to keep the men and machinery employed some commercial work is done. This is in the nature of specialty products, such as are required for scientific purposes—for instance, color sensitive plates and films. Frequently there is a call for special plates for astronomical purposes and ultra-violet and infra-red photography, etc. All such special orders are filled in the research factory. In the laboratory are also made many shades of light filters used for the photography of colored objects and also for color photography. The plant for dealing with the gelatine of which these filters are made, is illustrated in one of the pictures. The exact shades of the filters are determined by means of a spectrophotometer. It is evident, of course, that these light filters require the most rigid control by means of special instruments. Another picture shows the work of determining the opacity of colored films.

In photographic work, the possession of accurate standards of light is of the highest importance and for this purpose a large bench photometer is used. The current of the lamps is taken from a storage battery and is governed by means of a potentiometer-galvonometer installation. Running on the same axis as the photometer is a precision, falling-plate sensitometer used to



Plant for dealing with the gelatine of which the light filters are made

A potentiometer and galvanometer installation controlling the lights of a large bench photometer



Determining the opacity of colored films or light filters by means of a spectrophotometer

expose photographic plates for very accurately known periods of time to lamps which are under control of the photometer bench.

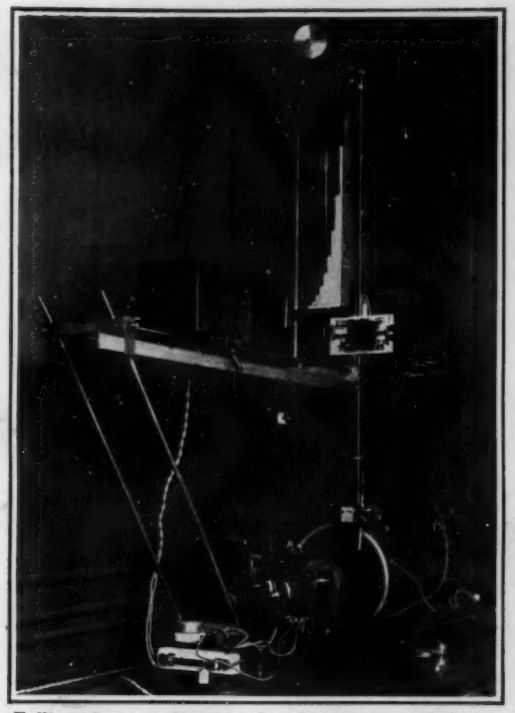
A new form of automatic sensitometer, electrically-controlled, has recently been developed. This is clearly shown in one of the pictures. A bank of controlled lights is used, before which the sensitized plate is set up. A shutter is operated to expose the plate, step by step, by means of a ratchet mechanism actuated by a solenoid. The solenoid, in turn, is operated by electrical contacts made through a perforated film. The film is of the usual motion-picture variety, designed to be fed by means of sprocket wheels driven by a motor. The perforations in the film are cut in accordance with any predetermined plan, depending upon the nature of the experiment, and after the apparatus has been set the exposure is made automatically, the shutter moving up one step every time a contact is made through the perforations in the film. This provides a very ready method of changing the periods of exposure, which can be done on the instant, by substitution of films.

Naturally the principal work done in this laboratory is of a chemical nature, and there are three special departments devoted to chemistry,—one has to do with inorganic, another with organic, and the third with colloidal chemistry. Other departments are concerned with physics and with general photography.

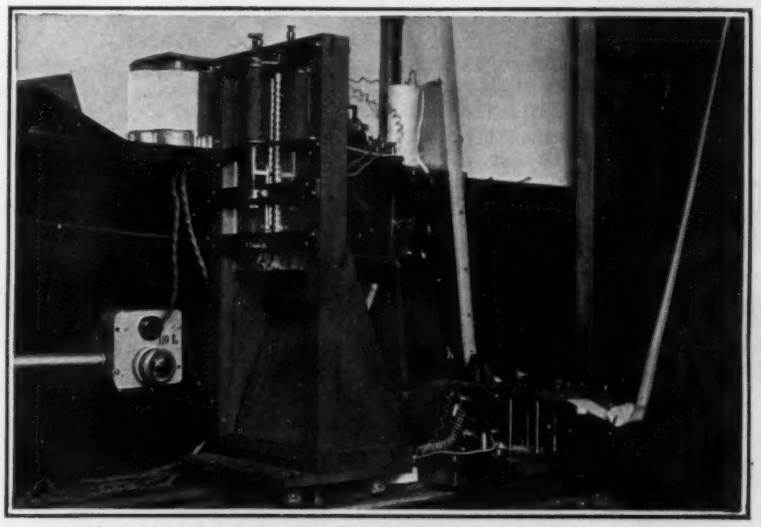
Although the laboratory is operated on a commercial basis, having as its main object to improve photographic products and processes, its director is not unmindful of the advantages of experiment in pure science and a certain amount of scientific exploration is undertaken merely for the love of science and to add to the general store of knowledge; even though there may be no direct bearing apparent upon the commercial products of the factory. As a matter of fact, seldom is any scientific discovery made that does not sooner or later have some practical application, and here is an illustration in point: Experiments were recently conducted to determine to what extent the acuity of the eye is affected by exposure to light. In other words, when the eye has been exposed to a strong light to what extent is it able to determine the difference between fine shades of light after the blinding light has been cut off. An instrument was devised to permit of making experiments in this line and some interesting results were obtained. Apparently the work had no bearing upon photography, and it was not possible to see what value it would have upon the commercial field. Recently, however, the Navy Department was anxious to know what effect glare has upon the eyes of a navigator, and what mechanical or optical aids would be required to enable him to see clearly despite the blinding reflection of the sun on the water. Immediately the theoretical work that had been carried out in this laboratory served to throw light upon the question and offered a solution of the problem presented by the Government.

It is becoming increasingly evident that research pays even when pursued in the field of pure science and many of our large research laboratories are engaged in a certain amount of such exploration, being convinced of its beneficial influence upon the purely commercial work of the rest of the laboratory. Many remarkable industrial developments have grown out of discoveries that have been made as a result of research work in which no commercial motives directed the course of investigation.

The great industrial awakening of this country is one of the blessings that has come out of this dreadful war, and if industrial research is properly pursued with a full appreciation of the value of pure as well as applied science, there is no reason why this country should not lead the world in the march of progress.



Falling plate sensitometer for the exposure of plates to standard light for accurately known periods of time



An automatic sensitometer in which the exposure periods are timed by a perforated film

The Bow of a Modern Battleship

NO, the accompanying illustration represents neither the head of some gigantic fish out of water and gasping in its death throes, nor the head of an Alaskan totem pole, nor a warrior on the Western front clad in his gas mask—it is merely a photograph of the bow of the United States dreadnought "Idaho," taken just before her launching on the Delaware River at the yards of the New York Shipbuilding Company.

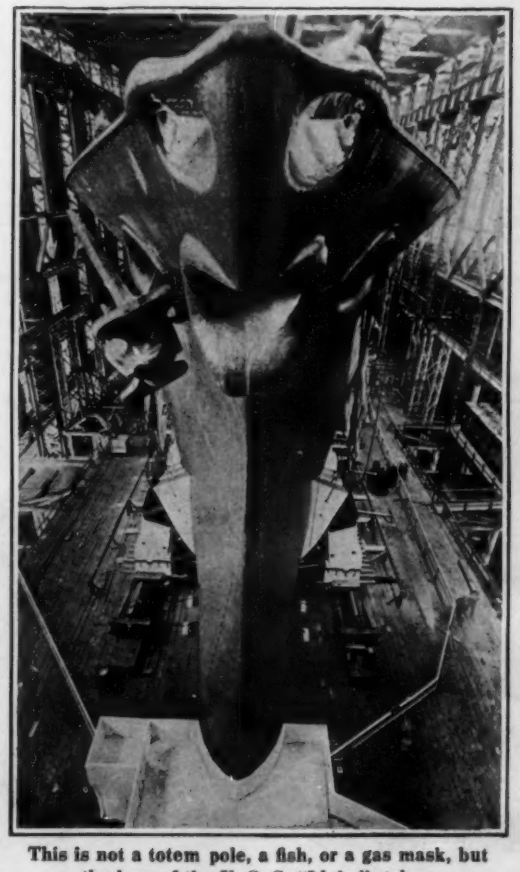
The amazing result is due to the unusual form of the bow, the long drawn out forefoot which has taken the place of the old ram, and also to an unusually accentuated perspective.

The "Idaho" like the two other sister ships of this class, the "New Mexico" and the "Mississippi," carries a clipper bow of the type which was universal in the earlier days of the trans-Atlantic steamship, and is still favored among the large sailing ships. It is this forward projection of the stem, bringing it nearer to the camera, that is answerable for the exaggerated size of the five hawserholes, of which there are two opening out at the rail of the forecastle deck and three at the level of the main deck below—one through the stemhead and one on either beam. To look at this ship, end on, it is difficult to realize that her beam is just under 100 feet—to be exact, 97 feet, 3 inches—but the extreme flare of the bow, which is very pronounced in our latest dreadnought cuts off any view of the after part of the ship and conduces to exaggerate the apparent slimness of the lower sections. The ram-like form of the lower part of the stem of the ship is retained not because the ship will ever attempt the old tactics of ramming but because Read-Admiral Taylor, Chief Constructor of the Navy, found in his model tank experiments that the retention of this form was conducive to speed.

The "Idaho" is a truly mighty ship, with a total length of 625 feet (the old "Oregon" was only 348 feet long), and a displacement of over 32,000 tons. Both her battery and her armor plan are unusually heavy; for she carries twelve 50-caliber, 14-inch guns in four turrets and she is protected by a belt of about 14 inches of armor and carries a maximum thickness of 18 inches of armor on her turrets.

As compared with the previous class of dreadnoughts, of which Admiral Mayo's flagship, the "Pennsylvania" is one, the "Idaho" carries her secondary battery, or anti-torpedo battery as it is now called, one deck higher, most of these guns being mounted on the main deck.

The most interesting feature of this ship is that she will be driven by the same system of electric drive as is doing such good work on the collier, "Jupiter," and for this reason her behavior will be watched with special interest. The electric drive is popular with our naval officers because of its flexibility and also because it is possible to instantly reverse, if so desired, when the ship is running at full power.



This is not a totem pole, a fish, or a gas mask, but the bow of the U. S. S. "Idaho", taken at her recent launching

The Current Supplement

AN interesting problem that has engaged the attention of scientific men for many years concerns the stability of the coasts bordering on the Atlantic Ocean, both of America and of Europe, and much evidence has been educed to demonstrate that there is a general and steady subsidence. An article in the current issue of the SCIENTIFIC AMERICAN SUPPLEMENT, No. 2168, for July 21st, entitled *Is the Atlantic Coast Sinking?* reviews the latest facts relating to the question, and tends to prove that no such subsidence is taking place. *Protecting Our Timber Resources* describes the application of the heliograph to the protection of our National Forests from fire, and is illustrated by several excellent photographs. *An Experimental Study of a Theory of the Complex Zeeman Effect* describes some recent investigations of an important scientific phenomenon, and is accompanied by a photograph and some diagrams. The interesting lectures on *The Electrical Properties of Gases*, by Sir J. J. Thomson are continued in this issue. *Tree and Plant Pests* describes and illustrates very fully various insects and diseases that cause immense damage every year. The article on *Natural Measurement of Time* is concluded. *Sighting Telescopes for Fire-Arms* describes the construction of devices for aiding in precision in long distance shooting, as applied both to field guns and military rifles. It is illustrated by a number of explanatory diagrams and cuts. *The Meaning of Bird Music* will appeal to many an outer, as it directs attention to the remarkable musical compositions uttered by wild birds and discusses the theory of their production. A number of musical notations of these songs accompanies the article. *Artificial Eyes* tells us something of the history of these desirable prothetic devices, and describes the delicate methods of fabrication employed by some makers. Another article of general interest treats of *Diastase in the Laundry.*

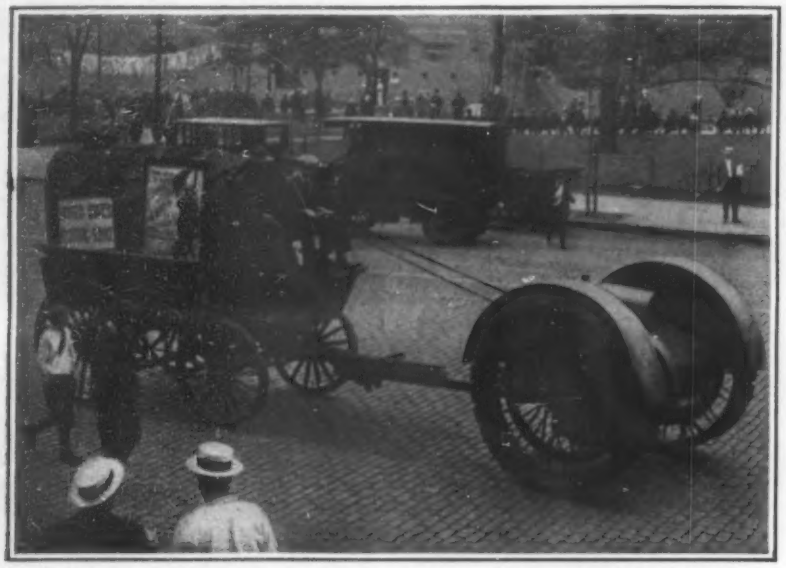
Projected Subway for Madrid, Spain

ACCORDING to *Vida Financiera* (Madrid), the Spanish Ministerio de Fomento has granted a concession, under date of January 12, to Don Miguel Otamendi for the construction and working, for a period of ninety years, of an underground electric railway system in the Spanish capital, to be known as the Metropolitan de Madrid Alfonso XIII. There will be four double-track lines. The capital necessary for the construction of the complete system, embracing a total distance of 14 kilometers (8.7 miles) is 30,000,000 pesetas (approximately $6,000,000). A period of eight years will be allowed for the completion of the undertaking. The first line to be constructed will cross the city from north to south; it will be 4 kilometers (2.5 miles) long, and is estimated to cost 8,000,000 pesetas ($1,600,000). Work is to be commenced shortly. This section must be completed within three years.

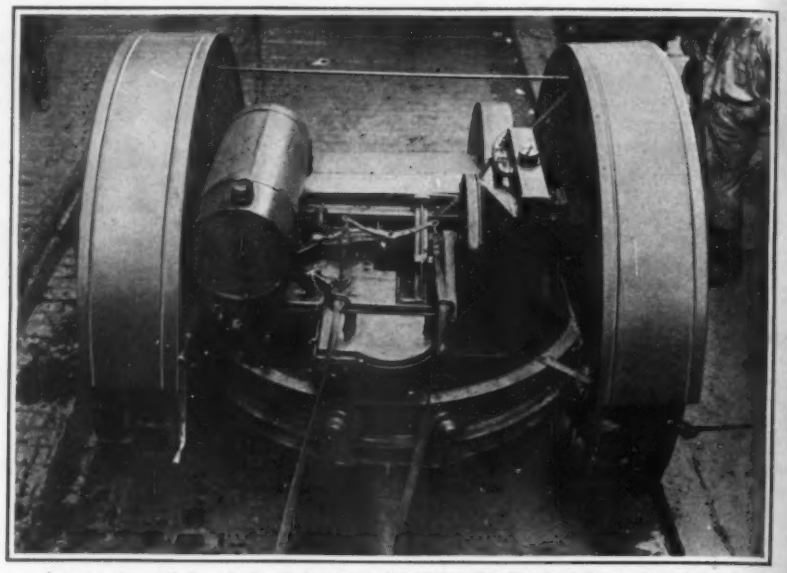
The Motor-Driven Commercial Vehicle

Conducted by VICTOR W. PAGE, M.S.A.E.

This department is devoted to the interests of present and prospective owners of motor trucks and delivery wagons. The editor will endeavor to answer any question relating to mechanical features, operation and management of commercial motor vehicles



Driven by reins in the same manner as a horse, this two-wheeled tractor is receiving much attention on the streets of New York city



A near view of the vitals of the "gasoline horse", showing the connection of the reins to the control mechanism

A Gasoline "Horse" That May Be Driven By Any Teamster

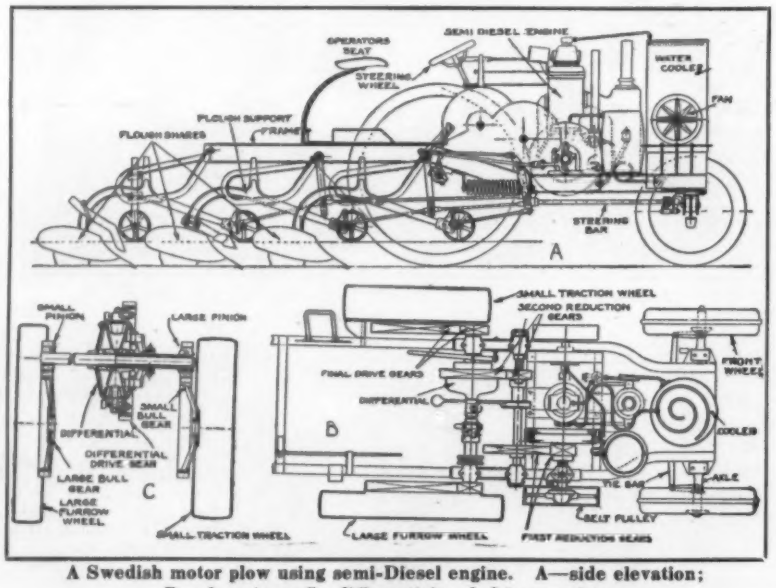
DRIVEN with reins like a horse, the two-wheeled tractor which can be seen daily on the streets of New York city presents an interesting development in gasoline traction. While it is being employed at present for hauling Army wagons through the thoroughfares of the big city in an effort to attract attention and stimulate recruiting, the so-called "Army horse" may be considered as more than a novelty; indeed, it is looked upon by Army men as a most practical type of military tractor, and this is verified by its service record on the Mexican border.

The "Army horse" or "gasoline horse" which appears in the accompanying illustration, is capable of hauling 15 tons. It is controlled by means of a pair of conventional reins, and is manipulated in the same manner as in driving a horse. Thus it is steered by pulling the corresponding rein, stopped by pulling both reins, and backed up by giving an additional pull. The tractor is started by giving both reins a jerk. All in all, the tractor can be driven by any teamster, which makes it especially valuable to our new Army because it lends itself to manipulation by men of slight training. It is also available for hauling in peaceful pursuits.

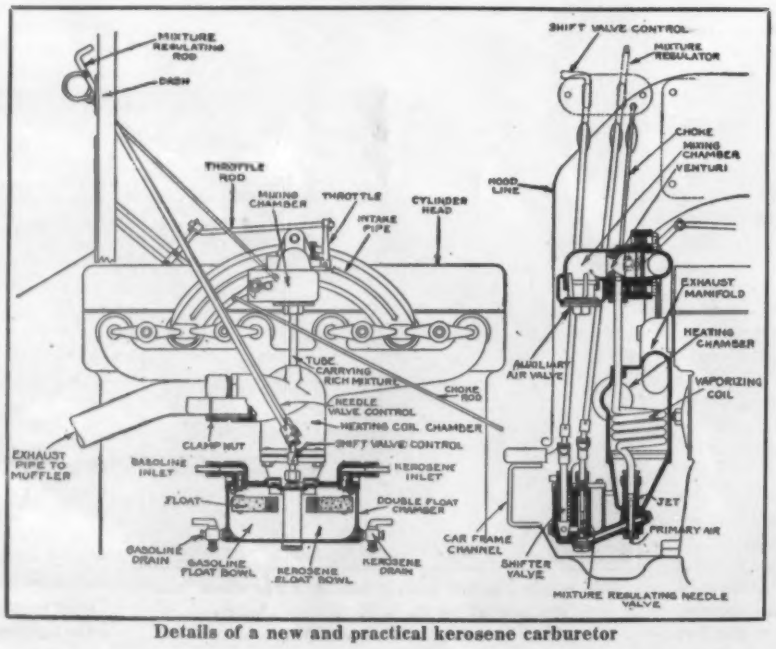
New Swedish Motor Plow Design

THE great demand for increased food production all over the world is reflected in augmented activity among designers of motor propelled agricultural machinery. The motor plow illustrated is a complete unit and is distinctive in the form of power plant employed as well as in other details. The machine is not a tractor, though an arrangement is provided by which the plows may be raised or made inactive and the rear end of the unit is provided with a drawbar so other implements, such as harrows, may be attached. The plows are permanently attached to the machine.

The general machine arrangement of parts may be clearly ascertained from the side view. The frame is made of I-section steel beams and is cambered in at the front and given a "kick up" at the rear so the plow supports, etc., are higher than the frame at the front. The steering is done by the Ackermann system in which the wheels are carried on dirigible spindles as in an automobile. The wheel spindles are turned by a geared steering arrangement comprising bevel and spur gearing. The rear wheels are traction members and are provided with grouters to give additional traction. The front wheels have a central flange to assist in keeping a straight path. As the right side of the machine is intended to run in the furrow, the right rear wheel is made of larger diameter than the left traction member. The right front wheel is set lower on the axle to secure the same results. On account of the difference in size between the driving wheels special compensating gear ratios are needed in the power transmission mechanism.



A Swedish motor plow using semi-Diesel engine. A—side elevation; B—plan view; C—differential and drive gearing



Details of a new and practical kerosene carburetor

The motor is a single cylinder vertical, two-cycle, semi-Diesel type operating with the hot bulb system of ignition. The fuel is either crude oil or kerosene and the engine is rated at 14 horse-power maximum. With this type of motor only air is drawn in and compressed, the fuel being supplied to the combustion head by injection at the right point in the stroke. The engine runs at 500 r.p.m. and consumes 10.5 ounces of fuel per brake horse-power hour. A belt pulley is provided so the engine can be used for stationary power plant work. The machine is rated at six acres per 10-hour day, plowing furrows 12 to 14 inches deep. As the plows are somewhat heavy, a power lifting arrangement is provided. The construction of the engine is such that it will run with equal facility in either direction so no reversing gears are necessary. When the machine is to be reversed, the engine is run in a reverse direction. The power output is as even as with a two-cylinder four-cycle engine. The machine weighs about three tons and has a speed of about two miles per hour.

Practical Kerosene Carburetor

MOTORISTS have realized for some time that a shortage of gasoline was inevitable at some future time and while the increasing price of gasoline has not been a serious drawback to the use of pleasure cars, it has been an item of moment in the operating expense of commercial vehicles of various kinds. A practical kerosene carburetor has been recently offered by a leading manufacturer that has been in process of development for several years and which was thoroughly tried out in the foreign market before it was introduced for domestic consumption. The carburetor will handle kerosene, benzol, distillate or any hydrocarbon with a final boiling point below 600 degrees. It can be utilized on either commercial cars or pleasure autos because it permits of flexible engine operation by throttle control.

The model illustrated was designed especially for use with a popular light car engine used in enormous numbers throughout the world. It is designed to use gasoline to secure an initial start and after the engine has operated for two or three minutes on the more volatile fuel, it may be supplied with kerosene for the remainder of the run. The principle involved is the preheating by the exhaust gases of a very rich mixture of kerosene and air and subsequently thinning this

(Concluded on page 52)

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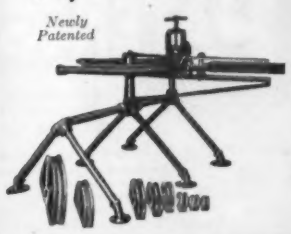

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Bends, horizontally, *any length* pipe. Bends 2-inch pipe to 90 degrees in one minute.

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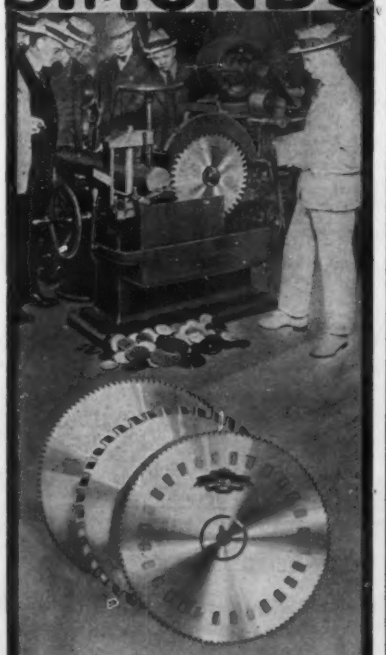

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Exploring Live Volcanoes

(*Concluded from page 37*)

laboratory. Fortunately many important studies of this general character can be made without a personal descent into the pit. The accompanying diagram illustrates the apparatus originally used by Perret, in 1911, to take temperatures and collect samples of lava. This consists of a trolley arrangement borne by a steel cable, stretched from edge to edge of the pit. The size of the trolley and the height of its supports are greatly exaggerated in the figure, and give an altogether inadequate idea of the size of the pit. The clear span between the supports is actually about 1,300 feet in length. Electric thermometers were used to measure temperatures.

The history of the Halemaumau pit is now recorded in great detail in weekly bulletins published by the Observatory. The same bulletins contain information concerning volcanic and seismic activity elsewhere in the Hawaiian Islands.

The Evolution of Artificial Dyestuffs

(*Continued from page 40*)

jected to the combined action of nitric and sulfuric acids. The strong affinity of the latter for water comes into play. The hydrogen and oxygen necessary to form water are extracted from the two associated substances. Nitric acid yields OH and the aromatic compound surrenders an atom of hydrogen, whose place is taken by the residue of the nitric acid molecule, NO_2. The extent and nature of the reaction are affected by the factors of time, temperature and proportions. Thus benzene can be transformed, at will, into mono-nitro-benzene or into any one of three di-nitro-benzenes.

Reduction.—The oxygen in a nitro derivative may be replaced by hydrogen, and the corresponding amido compound thus formed. For example, benzene, C_6H_6 is changed by nitration into nitro-benzene, $C_6H_5NO_2$, and that, in turn, by reduction, into amido-benzene or aniline, $C_6H_5NH_2$. The reaction depends upon the liberation of hydrogen, which in the nascent state easily appropriates the oxygen atoms of the nitro group, introducing in their stead other hydrogen atoms. Iron filings or zinc dust with acetic, hydrochloric or sulfuric acid form the customary reducing agents.

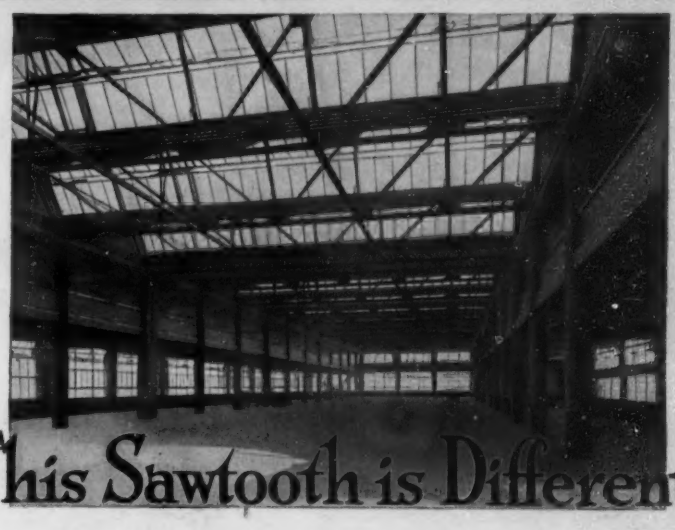
Sulfonation is wholly similar to nitration, strong sulfuric acid, and very frequently fuming sulfuric acid, being employed in place of nitric. The sulfo group, SO_3H, replaces a hydrogen atom in the aromatic compound; thus benzene gives rise to benzene sulfonic acid, $C_6H_5SO_3H$. These derivatives are genuine acids; the hydrogen atom can be replaced by metals, ammonium groups, etc. Thus we have potassium benzene-sulfonate, $C_6H_5SO_3K$. Theoretically, at least, for every nitro derivative of an aromatic compound there is a corresponding sulfo derivative, and many of these are of great importance in the synthesis of valued dyestuffs.

Chlorination.—This term applies to the action of dry chlorine gas upon aromatic compounds. One half of the chlorine employed is recovered in the form of hydrochloric acid, HCl, the other half replaces hydrogen in the aromatic compound. The gas used for this purpose is obtained in connection with the electrolytic production of caustic soda from salt. It is liquified for transportation and allowed to volatilize as needed. The use of bromine and iodine in reactions similar to those of chlorination is limited.

Oxidation is frequently affected by the aid of bichromates, chlorates, permanganates, lead peroxide or manganese dioxide.

Caustic Fusion is performed chiefly with sulfo acids, occasionally with chloro derivatives. The hydroxyl group, OH, replaces chlorine or the sulfo group. Thus benzene-sulfonic acid, on fusion with caustic soda, yields phenol, or carbolic acid, C_6H_5OH.

Alkylation.—This term is usually applied to the replacement of hydrogen in the hydroxyl or amido groups of aromatic compounds, by the radicals methyl, CH_3,



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Different in sash—different in ventilation—enormously different in result!

A thousand men and girls, working at top speed on this Goodrich fifth floor, "assemble" millions of pairs of rubber footwear every year. For super-efficient production without strain super-efficient ventilation and lighting are demanded.

First, the sawtooth continuous sash is **top-hung** and unbroken, therefore rain proof when open. Stale air can escape, rain or shine.

Second, similar continuous sash over the windows admits fresh air constantly.

Third, both inlets and outlets are **uniform the entire length of the floor.** All the sawtooth lines in each wing are controlled **simultaneously** by one electric motor. One operation opens or closes all the inlet sash on either side.

Results: (a) Fresh air reaches every part of the floor; stale air goes straight up and out; no pockets or back currents; (b) Ventilation controlled by foreman; it is not dependent on the caprice of the workers; (c) Abundant lighting over entire area of 1¼ acre.

This ultra-productive Goodrich building is but one of many where the co-operation of our Engineering Department has produced better-than-usual results. It is described, with others, in a booklet, "Air, Light, and Efficiency," sent free on request.

Every new factory presents its own problems in lighting and ventilation. Let us help you with yours.

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Lupton Steel Sash, Counterbalanced Type, in windows throughout; equal top and bottom openings insure ventilation on floors 1 to 4.

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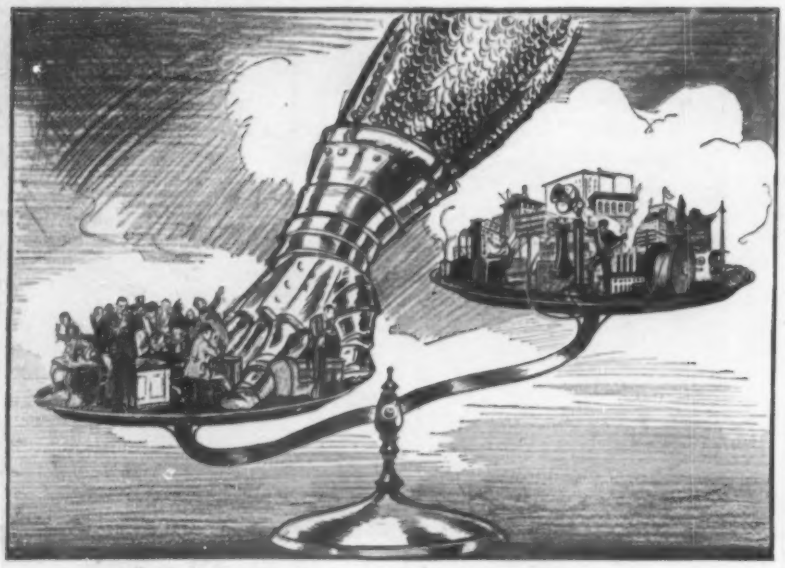

The Weight of War

The heavy hand of war has disturbed the balance between supply and demand the world over. Our problem of serving the public has all at once assumed a new and weightier aspect.

Extraordinary demands on telephone service by the Government have been made and are being met. Equipment must be provided for the great training camps, the coast-defense stations must be linked together by means of communication, and the facilities perfected to put the Government in touch with the entire country at a moment's notice.

In planning for additions to the plant of the Bell System for 1917, one hundred and thirty millions of dollars were apportioned. This is by far the largest program ever undertaken.

But the cost of raw materials has doubled in a year. Adequate supplies of copper, lead, wire, steel and other essentials of new equipment are becoming harder to get at any price, for the demands of war must be met.

Under the pressure of business incident to war, the telephone-using public must co-operate in order that our new plans to meet the extraordinary growth in telephone stations and traffic may be made adequate.

The elimination of unnecessary telephone calls is a patriotic duty just as is the elimination of all waste at such a time. Your Government must have a "clear talk track."

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or ethyl, C_2H_5, present in wood alcohol or in grain alcohol. The alcohols or methyl or ethyl chloride are used along with hydrochloric acid, and the operation is effected at elevated temperatures, under pressure. As an example, aniline, $C_6H_5NH_2$, can be transformed into methyl-aniline, $C_6H_5NHCH_3$, or dimethyl-aniline, $C_6H_5N(CH_3)_2$.

Condensation.—This term refers to a large class of operations, in which two molecules of the same substance, or of different substances, unite to form a new compound, with elimination of water, ammonia, or hydrochloric acid. Sulfuric acid, in considerable excess, is the usual condensing agent. The chlorides of aluminum, antimony, phosphorus, sulfur and zinc are occasionally employed for the purpose. The manufacture of the so-called ketone group of colors is a good illustration of condensation on a wholesale scale. Use is made here of the compound known as tetra-methyl-diamido-benzophenone, termed Michler's ketone, after the inventor. By condensationwith twenty-four different coal-tar intermediates, this yields the same number of widely used artificial colors. Thus from the condensation of the ketone with benzoic acid, chrome green is obtained; the reaction with dimethyl-aniline gives methyl-violet, etc.

Diazotizing and Coupling.—The formation of diazo compounds is one of the most important in the whole range of color manufacture. Any primary amine, such as aniline, yields on treatment with nitrous acid, HNO_2, the corresponding diazo derivative. Thus aniline, in the presence of hydrochloric acid, changes into diazo-benzene chloride, $C_6H_5N{:}N{-}Cl$. The reaction is simple and quantitative, the most easily controlled of all the reactions of color manufacture. An essential condition of success is to maintain the temperature below 4° C., preferably at zero. The diazo compounds, as a rule, can exist only in a cold solution. In this form they react most readily with a great variety of aromatic substances. The term coupling is applied to this reaction. Thus the diazo-benzene chloride mentioned above, upon gently warming its solution with aniline, yields amido-azo-benzene chloride, $C_6H_5N{:}N{-}C_6H_4NH_2.HCl$, the well-known dye aniline yellow. With m-phenylene-diamine, the same compound yields another famous dye, chrysoidine.

Carboxylation.—The introduction of the acid carboxyl group, COOH, into the molecules of phenol and its homologues is effected by the joint action of caustic soda and carbon dioxide. Thus phenol, C_6H_5OH, is easily transformed into salicylic acid, $C_6H_4.OH.COOH$.

Liming.—Occasionally the products of sulfonation or chlorination are treated with lime, in order to accomplish the separation of several closely allied compounds by means of the differing solubilities of their calcium salts.

Fusion with Sulfur and Sulfides.—An important class of dyestuffs, the so-called sulfur colors, is prepared by the fusion of various coal-tar intermediates with either sulfur, alkaline sulfides, or mixtures of the two.

The above constitute all the major chemical operations in use by the manufacturer of artificial colors. We must bear in mind, however, that the possibilities of the coal-tar compounds are from the theoretical standpoint literally numberless. For every synthetic dye which has actually conquered its position in the commercial world, somewhere between a hundred and a thousand tinctorial compounds have been created by the coal-tar chemists, tried, and found wanting. Few of these are chronicled with any fullness of detail.

Mechanical Operations of Color Manufacture

The visitor to a color factory gazes upon a bewildering maze of closed and open containers, pipes and stills and presses. When subjected to strict classification, however, there are but a few general types.

The operations outlined above are carried out under varying conditions of temperature and pressure. In most cases

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constant agitation of the contents of a vessel is necessary. This is effected by a series of blades attached to a central axis. Heat is usually communicated by circulation of steam through coils of pipe contained in the vessels in which reactions are under way. Frequently, however, these are jacketed with an outer wall so that steam surrounds the entire bottom and sides.

It is often the case that volatile products or noxious fumes are emitted. Here the vessels are tightly covered, with suitable vents. Occasionally condensers are attached, so that volatile liquids are not lost, but flow back constantly into the chamber where the reaction is taking place. In numerous instances the reaction must go on under high pressure. The heavily constructed vessels provided for this purpose, with agitating mechanisms and steam jackets, are termed autoclaves. Necessary adjuncts are thermometers, pressure gages and safety valves.

Of all the mechanical operations involved, that of filtration is the one which appeals most to the eye. The batteries of modern filter presses, highly perfected in every detail, render it possible to separate precipitates in an incredibly short time, and to wash them free from the last trace of the liquors in which they have been produced. The swiftly whirling centrifugal, of such vast convenience to the sugar manufacturer, also comes frequently into play. Vast drying chambers are, however, in constant requisition to remove every vestige of moisture from finished dyestuffs, before they are packed for shipment.

The Evolution of H-acid

To illustrate in concrete form the workings of a coal-tar color factory, the sequence of operations in the manufacture of a single intermediate may be outlined. Choice will be made of one with a somewhat formidable chemical name—1.8-amido-naphthol-3.6-disulfonic acid. In commerce and in the color factory it is ordinarily termed H-acid.

The starting point is naphthalene, $C_{10}H_8$, secured, in a crude form, from the carbolic oil fraction of coal-tar distillation by allowing the latter to stand for a few days at as low a temperature as possible. The impure crystals are fused and allowed to recrystallize slowly in large vats. This product is washed with hot caustic soda solution to remove phenols, with strong sulfuric acid to remove bases, and finally with very dilute caustic soda. It is then submitted to heavy hydraulic pressure in bags, or is whizzed in a centrifugal and is ready for most uses. If desired in very pure form it is either distilled again or sublimed.

Five successive main steps are required to transform this purified naphthalene into the desired acid, each one being accompanied by various minor mechanical operations.

1. Naphthalene is heated for several hours with concentrated sulfuric acid at 180° C. The product is dissolved in water, freed by filtration from a little dinaphthyl-sulfone formed at the same time, and by addition of common salt, precipitated in the form of sodium salt of b-naphthalene-sulfonic acid, $C_{10}H_7SO_3H$.

2. This is next submitted for a short time to the action of concentrated sulfuric acid at 160°. The main product is naphthalene-2.7-disulfonic acid. A certain amount of the isomeric 2.6-acid is formed at the same time. By liming the two are separated; the calcium salt of the latter is insoluble in water, while that of the former is easily soluble. After filtration the calcium salt is decomposed by sulfuric acid, and naphthalene-2.7-disulfonic acid, $C_{10}H_6(SO_3H)_2$, is obtained in a pure form.

3. This acid next undergoes nitration. The product is 1.8-dinitro-naphthalene-3.6-disulfonic acid, $C_{10}H_4(NO_2)_2(SO_3H)_2$.

4. This in turn undergoes reduction, yielding 1.8-diamido-naphthalene-3.6-disulfonic acid, $C_{10}H_4(NH_2)_2(SO_3H)_2$.

5. Upon treatment with dilute sulfuric acid at 120° one of the amido groups, NH_2, in the last-mentioned acid is replaced by the hydroxyl group. The re-

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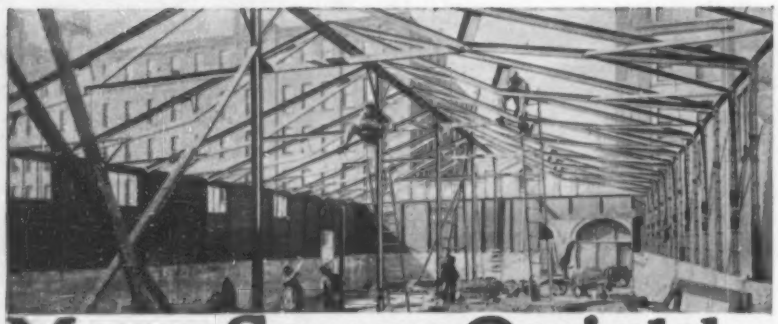

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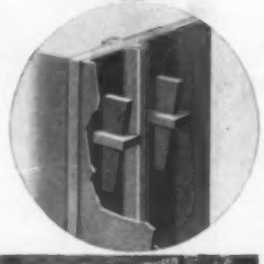

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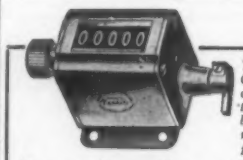

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sultant product, $C_{10}H_4.OH.NH_2.(SO_3H)_2$, is the desired intermediate, H-acid.

The numerals in the above formulae serve to indicate the relative positions in the naphthalene molecule of the substituting groups and thus to distinguish between the various isomers. Theoretically there are 210 possible amido-naphthol-disulfonic acids. A relatively small number of these are actually known.

The pathway from naphthalene to H-acid is evidently tedious and complicated. The coal-tar crude costs today 9 cents per pound; the H-acid is quoted at $2.50.

Colors Evolved from H-acid

When the color manufacturer, however, once has this helpful intermediate in his possession the way is open for the easy production of a large variety of staple dyes by the successive steps of diazotizing and coupling, as described above. With the help of aniline and p-nitraniline, or sulfanilic acid and a-naphthyl-amine, or aniline, benzidine and m-phenylene-diamine he can make excellent blacks, the rapid production of which, on a large scale in American works, has been of pronounced assistance in lessening the discomforts of the color shortage during the past year. Using other similar combinations with intermediates of simpler manufacture, and the all-potent diazo reaction, we can produce a great variety of standard blues, violets, greens, mauves, olives, bronzes, blacks and blue-blacks, each possessing its own individuality, each of specific applicability to some of the many phases of the dyer's art. All are dependent for their production upon H-acid and the sequence of chemical and mechanical operations outlined above, as well as upon the series of operations involved in the preparation of two or three less complicated accessory intermediates required at the final step in the evolution of each separate color.

In reviewing this complex of chemical and mechanical activity, and in considering the highly specialized human intelligence needed to control and coördinate the multiple factors, need we wonder at the confidence of those directing the great color works of Germany in asserting that a comprehensive American coal-tar dyestuff industry could never be created? And can we refuse an ample measure of patriotic admiration and generous cooperation to the plucky American chemists who are, today, actually creating that selfsame industry?

Practical Kerosene Carburetor

(Concluded from page 48)

out by addition of supplementary cold air.

The accompanying illustration shows the carburetor in part section. It will be seen that two float chambers are provided, one for kerosene, the other for gasoline. The fuel is controlled by the conventional float mechanism. A shifter valve is used to control the fuels and select that to be used. The fuel passes through a nozzle or jet, the amount passing through being controlled by an adjusting needle valve. It is atomized at the top of the jet by an air blast induced by the engine suction in the usual manner, the primary air entering through a small opening at the base of the jet. This has such a small area that only a small fraction of the air required for combustion is sucked in, and of course the resulting mixture is very rich in fuel. This rich fuel mixture is drawn through a coiled, small bore vaporizing tube seated in the exhaust manifold and surrounded by the hot gases. The coil becomes very hot, a temperature of about 500 degrees Fahrenheit being attained after the engine has been in operation a few minutes. This coil supplies the rich vapor to the mixing chamber, a stuffing box at the top preventing leakage of air. Additional air is taken in to dilute the mixture through an auxiliary air valve, the opening of which is automatically controlled by the engine suction as it varies due to different throttle openings. The mixture from the mixing chamber is drawn into the combustion head and is of the proper composition to furnish an energetic explosion.

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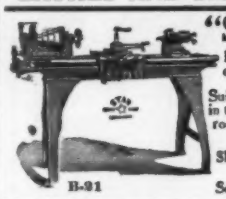

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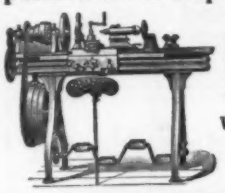

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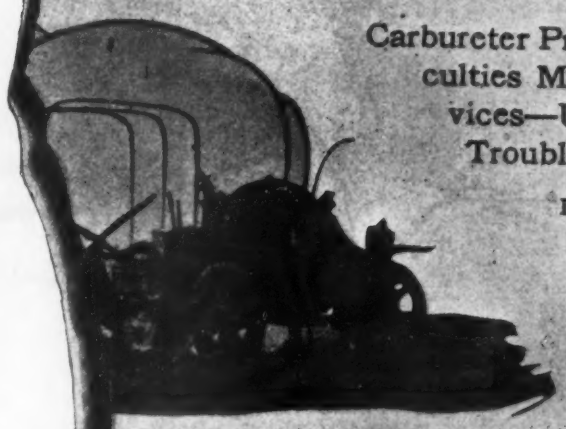

n fire, after being hit by a German shell

¶ *EDITOR'S NOTE—In this article Mr. Bradley, special correspondent of THE AUTOMOBILE with the allied armies, outlines in detail the chief troubles and defects brought out by war in the design of cars and trucks in the Italian service. During his work of several months as an ambulance driver, Mr. Bradley was in daily contact with army vehicles and the men handling them, so his knowledge of the subject is at once accurate and comprehensive.*

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Delco lighting sets on Buicks proved very satisfactory. The writer can speak from personal knowledge of half a dozen cars which since August, 1916, to the present date have been behind the trenches and ahead of the artillery and never under cover, even for repairs. Most of the drivers had very little mechanical knowledge, and it was known that some had run their cars for 12 months without oiling or giving any attention to the generator. Yet no trouble developed on these cars.

writer was connected were working so near the front that

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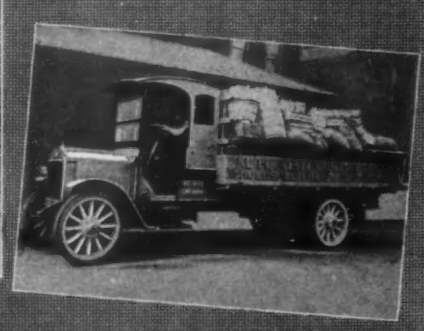

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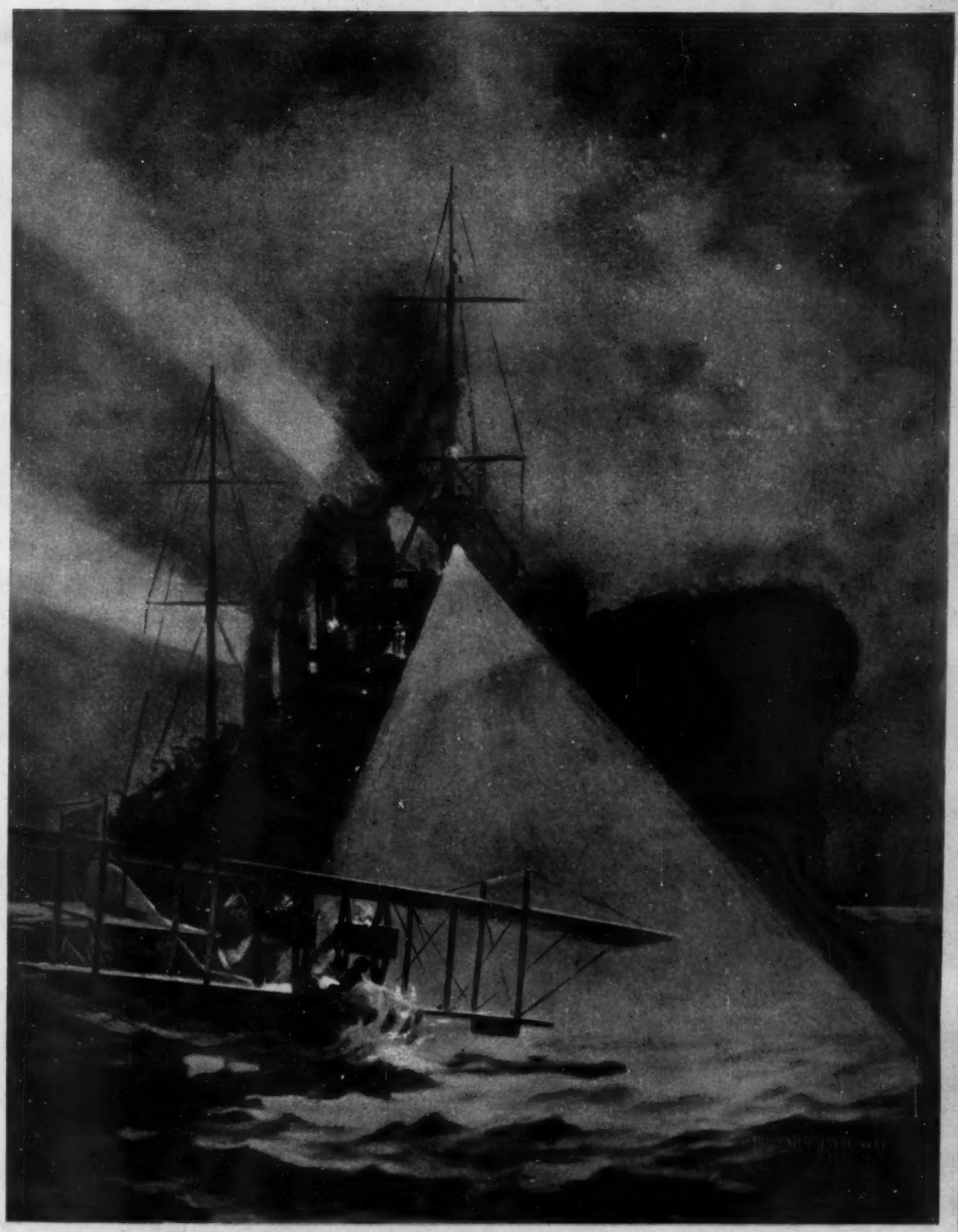

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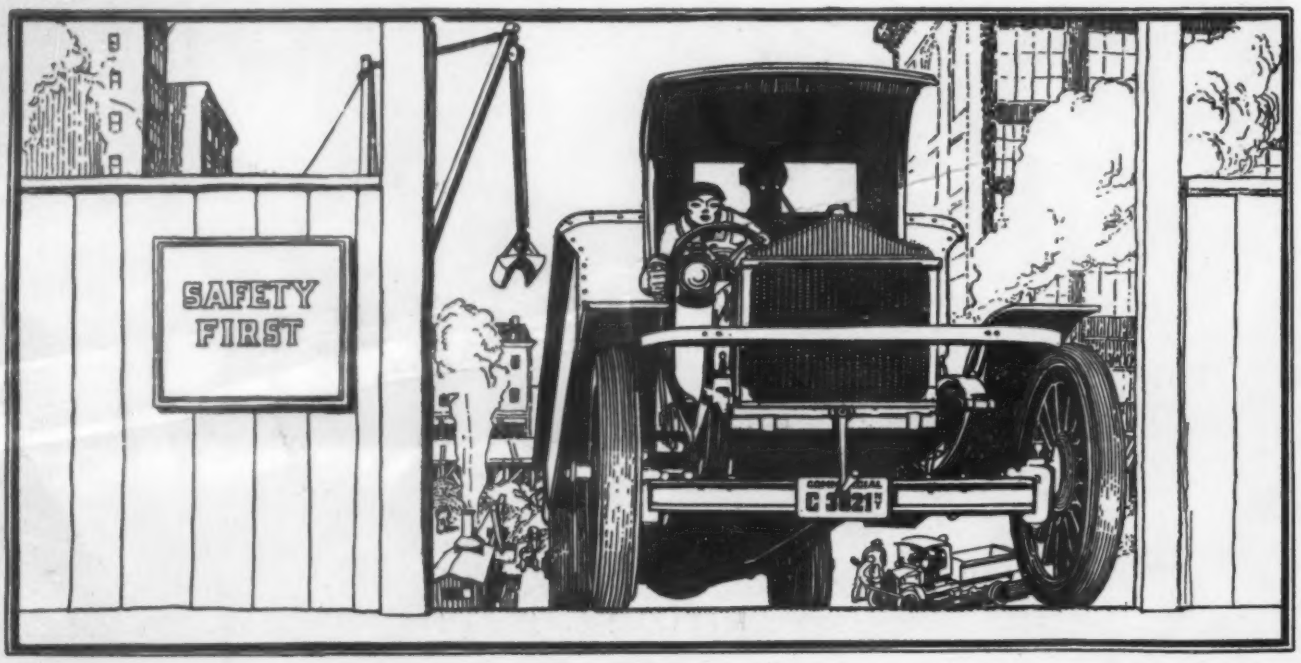

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